

Biological Elements

Biodiversity

Aquatic Ecosystems and Essential Fish Habitat

Fire Management

Insects and Diseases

Forested Vegetation

Plants

Wildlife

Biodiversity

Introduction

Biodiversity includes the ecosystems, plant and animal communities, species, genes, and processes through which individual organisms interact with one another and with their environment. Natural disturbance processes and human influences both affect the biodiversity of an area. Human induced changes in landscape pattern can be assessed by comparing ecological conditions that existed prior to modern human settlement of the area to current conditions. Most species of plants and animals on the Chugach National Forest are protected by using a coarse filter strategy (entire ecosystems and landscapes) of maintaining the components of vegetation composition and structure that are essential to their habitat needs. Rare species with narrow ecological amplitudes requiring specific habitat conditions are managed through a fine filter strategy (individual species and their habitats). Potential impacts to fragmentation, perforation, late successional and old growth forests, and landscape patterns characteristic of forested cover types are specifically assessed.

The conservation of biological diversity or “biodiversity” is of national and global concern. Biodiversity may be defined as “the full variety of the life in an area, including the ecosystems, plant and animal communities, species, and genes, and processes through which individual organisms interact with one another and their environments” (USDA Forest Service 1992b).

Biodiversity combines the physical environment with the biological environment. Both are influenced by, and in turn influence, the human environment. The physical environment consists of soils, water, and air. The biological environment is the pool of available species that successfully compete for existence in an area. This includes the full complement of living organisms - from inconspicuous soil bacteria and fungi to the more visible vascular plants and animals.

Biodiversity is understood in terms of the natural and historic numbers and distributions of plants and animals, habitats, and communities. To evaluate the biodiversity of the Chugach, it is necessary to examine this variability over time. Over these long periods, plants and animals have fluctuated with changes in climate. Their number and distribution have changed because of the species interactions, migrations into and out of the region, and other factors.

Natural processes. One way to promote biodiversity is to accept, where appropriate, the outcomes such natural processes as fire, windstorms and insect infestations. Many plants and animals evolved in response to such disturbances are suited to live in an environment in which they occur. For instance, wildfire has played a role in the origin of the mixed conifer and hardwood stands on the Kenai Peninsula (Potkin 1997). Insects and diseases, and the conditions that favor them, further shape the structure and composition of the spruce and mixed spruce forest communities on the Kenai Peninsula.

Human influences. Human influences also play a role. Some species, such as the Sitka black-tailed deer, mink, and noxious weeds, have been intentionally (or unintentionally) introduced to the Forest while others, such as the Kachemak gray wolf, have been extirpated. Humans have also had a profound effect on disturbance regimes particularly on the Kenai Peninsula.

Variability. Biodiversity is never stable through time; it fluctuates in response to ever-changing human and environmental influences. Some of the Forest exists in the same conditions that were present in the area before large-scale human development began. The Kenai Peninsula and Copper River Delta are currently undergoing responses to large-scale environmental conditions that have changed vegetation succession patterns or stand conditions. On the Kenai the changes are in response to a spruce beetle (*Dendroctonus rufipennis* Kirby) infestation that has affected over 40 percent of the forests since the late 1950s (DeLapp et al. 2000). Vegetation on the Copper River Delta is undergoing extensive succession in response to the 1964 earthquake, which uplifted the area between 6 and 11 feet (DeVelice et al. 1999b).

Scales of biodiversity. Biodiversity occurs at the following four scales (Noss 1990):

- **Genetic diversity** - the genetic variation within and among individuals and populations of the species that influences such things as adaptability and resistance to stress.
- **Species diversity** - the variety of different species found in an area. Some species are commonplace; others have small, reduced, or even threatened populations.
- **Community or ecosystem diversity** - the association of different species and their interactions with one another and physical environment.
- **Landscape or regional diversity** - the variety of communities or ecosystems over a larger area.

Conservation of biological diversity requires a dual strategy that addresses both the habitat needs of individual species and entire ecosystems (course filter analysis). The traditional species-by-species approach is important for management indicator species, sensitive species, and other species of special concern (fine filter analysis).

In this analysis, biodiversity is described in terms of:

1. Ecoregions;
2. Habitat Diversity;
3. Expected Range of Variability; and,
4. Wildlife – Coarse Filter.

Legal and Administrative Framework

- The **National Forest Management Act of 1976 (NFMA)** states that the forest plan must “provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area.”
- **Ecosystem Management** In 1992, the Chief of the Forest Service issued a statement committing the Forest Service to the practice of ecosystem management, which is an ecological approach to managing national forest and grasslands for multiple purposes.
- **The Endangered Species Act of 1973** governs the protection of listed species and the ecosystems upon which they depend.
- The **Forest Service Manual (2672)** requires the Regional Forester to identify sensitive species occurring within the region.
- The **Forest Service Manual (2672.4)** requires that a biological evaluation (BE) be prepared for all Forest Service activities to address impacts to Forest Service sensitive species.
- **36 CFR 219.27 (g)** states that management prescriptions, when appropriate and to the extent practicable, shall preserve and enhance the diversity of plant and animal communities.
- **36 CFR 219.19** requires the Forest Service to identify and prevent the destruction or adverse modification of habitat determined to be critical for threatened and endangered species. It states that fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species. Viable populations are defined as those with sufficient numbers and distribution of reproductive individuals to ensure their continued existence in the planning area.

Key Indicators

- Changes in the regional landscape
- Changes in land cover, vegetation and forest structure
- Bioenvironmental classes (generalized climate, vegetation, and landforms)
- Wildlife species richness by prescription category
- Wildlife species richness by land cover class and habitats of special interest

Resource Protection Measures

Ecosystem processes influence plant productivity, soil fertility, water quality, and many other environmental conditions affecting the health of the Chugach

National Forest. These processes are controlled by the diversity of plant and animal species present on the Forest.

Much of the Chugach National Forest remains largely unaltered by direct human activities. The Kenai Peninsula is where the bulk of historic large-scale changes in vegetation have occurred in response to human activities (including mining, logging, land clearing, and fire disturbances). Natural and human-caused events may diminish the natural diversity of plant and animal species and habitats. When conditions are outside of the range of natural variability, management action (or inaction) may be necessary in order to restore healthy ecosystem processes.

NFMA regulations require that viable and well-distributed populations of all native (and desirable non-native) resident species be maintained across the national forest. All management activities on national forest lands are evaluated in order to satisfy these regulations.

Affected Environment

Introduction

A regional landscape approach was used to assess how well various alternatives will allow the Forest to meet the following goals:

“Maintain the abundance and distribution of habitats necessary to support viable populations of existing native and desired non-native species.”

“Maintain habitat to produce sustainable wildlife populations that support the use of fish and wildlife resources for hunting, fishing, subsistence, and other values.”

“Emphasize maintenance of fish and wildlife habitat in 501(b) area of the Chugach National Forest.”

Biological diversity encompasses the variety of genetic stocks, plant and animal species and subspecies, ecosystems, and the ecological processes through which individual organisms interact with one another and their environments. The National Forest Management Act (NFMA) requires consideration of biological diversity for the area covered by each forest plan.

Biological diversity is defined and understood in terms of the natural and historical numbers and distributions of plants and animals, habitats and communities. For instance, in an old-growth forest ecosystem, much of the biodiversity is found within stands of old growth: variations in tree heights and species, differences in understory species, the presence of small openings within a stand, etc. This is the natural habitat for many of the animals living there, and defines the biological diversity important for their survival. Creating a greater amount of younger aged stands of trees may increase the absolute diversity of tree stands, but it may reduce the natural diversity of the ecosystem by creating more young stands than naturally or historically occur. It also reduces the

amount of diverse, usable habitats for the species conditioned to old-growth forests and the biological diversity inherent in old growth.

The conservation of biological diversity commonly requires a dual strategy addressing both individual species as well as entire ecosystems (Marcot et al. 1994). The traditional species-by-species approach is important for featured or management indicator species, sensitive or rare species, and for recovery of federally designated threatened or endangered species. Additionally and perhaps more important, a more comprehensive strategy focused on higher levels of biological organization and ecosystems may be necessary to conserve rare or declining habitats such as old-growth forests, plant and animal communities and ecosystems, as well as the entire complement of associated biota and ecological processes (Noss 1991, Scott et al. 1991, Franklin 1992).

Through this approach, the following basic principles as described by Concannon and others (1999) were considered:

1. Minimizing the fragmentation of habitats across the landscape;
2. Conserving large blocks of habitat at the regional landscape scale;
3. Conserving blocks of habitat close together and in contiguous blocks;
4. Maintaining corridors between large blocks of habitat; and,
5. Maintaining favorable habitat conditions for target species across their native range.

The regional landscape approach allows us to put the Chugach National Forest into perspective when considering the range of natural communities (Noss 1990) and species and community diversity on the landscape. Using a landscape approach also makes it possible to identify ecological processes, such as natural disturbance regimes, hydrologic processes, nutrient cycles, and biotic interactions essential for maintaining the natural variability of the landscape or regional biodiversity (Austin and Margules 1986). This constitutes the "coarse filter" approach to biological conservation (Hunter 1991).

The net effect of using the landscape approach in the coarse filter analysis allows us to evaluate how well the communities, structure, and processes of various landscapes are to be managed under different alternatives. How each alternative considers every kind of habitat, community, or ecosystem in terms of management protection was determined using a landscape analysis approach. The protection status provided to these ecosystems will be determined by considering the category of each land management prescription to the protection status levels of Duffy and others (1999) and how they are applied on the landscape.

The coarse filter approach to forest management is a strategy for maintaining the viability of most species present on the Chugach by maintaining the components

of ecosystem composition and structure that are believed to be essential to their habitat needs. The underlying concept is that a representative array of vegetation cover types will include the appropriate vegetation mosaics that will accommodate most species. The discussions concerning coarse filter are found in the following sections. For this coarse filter assessment, the location and distribution of species and ecosystems diversity at the Ecoregion, Forest, and within the Forest scales are considered.

For the Chugach National Forest, habitat needs for sustaining viable populations of individual species are addressed first by the coarse filter land allocation approach, and then by guidelines judged necessary for specific species or groups of species using the fine filter. Habitat distribution for well-distributed populations will be provided at several scales. Timber harvest is projected within four of ninety-five watershed associations. All alternatives will provide large blocks of habitat that would remain intact and essentially unmodified at the watershed association and geographic area scale.

The forest types most affected by resource management of the Chugach are the old-growth structural stages of the needleleaf and mixed needleleaf/broadleaf forests. The biological diversity associated with these forests is only beginning to be recognized and described. For instance, Franklin (1992) estimated that invertebrate biota, creatures essential to ecosystem function through such processes as nitrogen fixation and decomposition, might represent over 90 percent of the species diversity of old-growth forests in the Pacific Northwest. The most conceivable way to address conservation of these and other elements of biodiversity is by using an ecosystem- or landscape-based strategy (see also Noss 1991).

Table 3-9: Biodiversity components and scales.

Component	Scale ¹
Composition	Landscape Types Communities Ecosystems Species Population
Structure	Landscape Patterns Habitats Genetic
Function	Landscape Processes and Disturbances Land Use Trends Interspecific Actions Life Histories

¹ Based on Noss

For the effects analysis presented later, it will be assumed that if functional and inter-connected ecosystems are maintained across the Forest, then the closely associated components and ecological processes will also be maintained.

Biological diversity within any ecosystem, from a regionally-defined ecosystem such as the Pacific Coastal Mountains Forest-Meadow Province down to a watershed, riparian area, or individual stand of trees, can be described in terms

of three components: composition, structure, and function. Composition refers to the numbers and types of species, plant communities, and smaller ecosystems within an area. Structure refers to the arrangement of these communities or ecosystems across a landscape, and how they are connected, to variations in tree heights and diameters within a stand or between stands, etc. Function refers to the interactions and influences between plant and animal species within an area - how each species uses its environment - and to natural processes of change or disturbance (wind, aging, etc.). Table 3-9 lists these components and some scales at which they can be described.

Ecoregions of the Chugach

The national hierarchical framework of ecological units provides a system for delineating ecoregions (ECOMAP 1993). Ecological units within the broader levels of the ECOMAP hierarchy include province and section. At the province level, the Forest resides within the Pacific Gulf Coastal Forest-Meadow and Pacific Coastal Mountains Forest-Meadow provinces (Bailey 1995). The section level includes the Alaska Mountains, Kenai Mountains, Chugach Mountains, St. Elias Mountains, Northern Gulf of Alaska Fiordlands, and the Northern Gulf Forelands sections (Davidson 1996). For the purposes of this Environmental Impact Statement an intermediate class between province and section was also developed called Ecological Region (Table 3-10).

Pacific Gulf Coastal Forest-Meadow Province

Lush, lichen-draped temperate rain forests of hemlock and spruce interspersed with open wetlands blanket the shorelines and adjacent mountain slopes along the Gulf of Alaska. A cool, hypermaritime climate dominates with minor seasonal temperature variation and extended periods of overcast clouds, fog, and precipitation. Snow is abundant in the winter and persists for long periods at sea level. Permafrost is absent. Tectonic events have raised and submerged various portions of the coastline over time. Common forest animals include black and brown bear and Sitka black-tailed deer. Bald eagles, common murre, Bonaparte's gulls, Steller sea lions, harbor seals, and sea otters teem along its endless shorelines. Numerous streams and rivers support Dolly Varden char, steelhead trout, and all five species of Pacific salmon. Salmon spawning runs deliver tremendous amounts of nutrients to aquatic and terrestrial systems. A fiordal coastline and archipelago exists around Prince William Sound and points west where continental ice sheets repeatedly descended in the past. Here, fjords formed where glacier-carved terrain filled with seawater after deglaciation. At the head of fjords lie broad U-shaped valleys that have steep, deeply incised sidewalls draped with hanging glacial valleys. A coastal foreland extends from the Copper River Delta southeast to Icy Point fringed by the slopes and glacier margins of the Chugach-St. Elias Mountains. Here, unconsolidated glacial, alluvial, and marine deposits have been uplifted by tectonics and isostatic rebound to form this relatively flat plain. Because of its geographic position, the foreland is water-drenched through persistent maritime precipitation and overland runoff from the mountains. The organic soils shed water slowly and are blanketed with wetlands among meandering and braided silt-laden streams.

Temperate rain forests of hemlock and spruce occur sporadically where soil drainage affords (e.g., moraines, stream levees, uplifted beach ridges). Rare dusky Canada geese and trumpeter swans nest on these wet flats where brown bear, Sitka black-tailed deer, and moose roam.

The Pacific Gulf Coastal Forest-Meadow Province has been recognized, as being globally important because approximately 25 percent of the world's coastal temperate rainforests occur here. According to Ricketts and others (1999; Key Number 23) this area is approximately 85 percent intact, (intact habitat being "relatively undisturbed areas that are characterized by the maintenance of most original ecological processes and by communities with most of their original suite of species"). Within this province, species richness (conifers, plant associations, birds, mammals) declines with increasing latitude (DeMeo et al. 1993). The Chugach is at the northern end of the province.

Old-growth forests within this province, in particular, are important fish and wildlife habitat, due to the unique structural attributes (multilayered canopies, diverse forb and shrub layers, coarse woody debris, large diameter trees, etc.) (Ricketts et al. 1999). These attributes begin to appear when a forest reaches 150 years, although this may vary by plant association (Capp et al. 1992).

Many species that are threatened in the lower forty-eight states are present in far greater numbers in this province (Ricketts et al. 1999). Some of the highest concentrations of bald eagles and marbled murrelets in North America occur in southeast Alaska, Prince William Sound, and the Kodiak Archipelago (Ricketts et al. 1999). Within this province is the Copper River Delta wetland complex, one of the largest contiguous wetlands found on the Pacific coast of North America (DeVelice et al. 1999a). The Copper River Delta is recognized as a rich waterfowl and shorebird breeding and migration area.

This province is considered to be Class III "Globally or regionally outstanding" that presents a rare opportunity to conserve large blocks of intact habitat. This province contains globally or regionally high levels of biodiversity or rare ecological processes (Ricketts et al. 1999).

Pacific Coastal Mountains Forest-Meadow Province

Arcing terranes of Pacific origin have been thrust onto the North American continent forming a rugged ice-clad mountain chain that surrounds the Gulf of Alaska. This is the largest collection of ice fields and glaciers found on the globe outside the polar region. These towering mountains of faulted and folded sedimentary rocks intercept an abundance of maritime moisture, mainly in the form of snow. Huge ice fields, snowfields and glaciers form a continuous matrix over these mountains interrupted occasionally by rock cliffs and small exposed peaks called "nunataks." In the summer, melt water accumulates atop the ice fields and glaciers forming rivulets that eventually plunge down vertical ice shafts called moulins. Where they exude onto coastal flats, glaciers spread to form expansive lobes that gush water at their edges. Some glaciers run all the way to tidewater. Ice sheets swelled during past glaciations, inundating surrounding lands along the coast as well as the Interior. The sheer height of these

mountains together with their expansive ice fields forms an effective barrier for Interior species except along the Alsek and Copper River corridors. Thin and rocky soils exist where mountain summits and slopes are devoid of ice, snow, and active scree. Here, alpine communities of sedges, grasses, and low shrubs grow which, in turn, support Dall sheep, mountain goats, hoary marmots, pikas, and ptarmigans. Broad U-shaped valleys, many with sinuous lakes, occur where glaciers and ice fields have pulled back sufficiently. Here, deeper soils have formed in unconsolidated morainal and fluvial deposits underlain by isolated pockets of permafrost. Alder shrublands and mixed forests occur on lower slopes and valley floors where moose and brown and black bears forage.

The Pacific Coastal Mountains Forest-Meadow Province has been characterized as “Bioregionally outstanding” for its biological distinctiveness (Ricketts et al. 1999; Ken Number 104). The ecosystems of this province remain generally intact, with their full range of top predators existing in their natural ranges of variation. The portion on the Kenai Peninsula holds particular biological interest as a mixing area of populations from the forests of both sides, specifically between the Snow River drainage on the west side to King’s Bay in Prince William Sound. Additionally, major rivers that bisect this province, including the Copper, provide migratory corridors for waterfowl, passerines, and terrestrial mammals that connect the coastal forests with interior areas. In addition, salmon stocks in this province are of continental significance (Ricketts et al. 1999).

Except for the Kenai Mountains Section, this province has suffered little habitat loss, degradation, or fragmentation. The Kenai Mountains Section is where the bulk of historic large-scale changes in forest composition and structure have taken place on the National Forest (DeLapp et al. 2000). These changes have been due to activities since settlement by Europeans and include mining, logging, land clearing, and fire disturbances. In addition, over 40 percent of the forested area of the Chugach National Forest in the Kenai Mountains Section has been impacted by the spruce beetle since the late 1950s (DeLapp et al. 2000).

Table 3-10 shows the hierarchy of spatial units used in the biodiversity assessment.

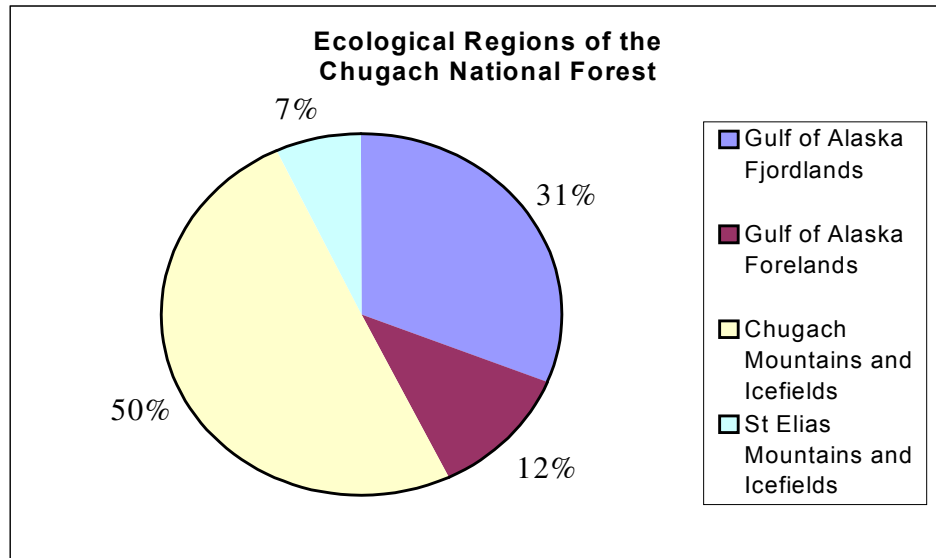
Table 3-10: Hierarchy of spatial units used in the biodiversity assessment.		
Province	Ecological Region	Ecological Section
Pacific Coastal Mountains Forest-Meadow	Chugach Mountains and Icefield	Alaska Mountain
	Chugach Mountains and Icefields	Kenai Mountain
	Chugach Mountains and Icefield	Chugach Mountain
	St. Elias Mountains and Icefields	St. Elias Mountain
Pacific Gulf Coastal Forest-Meadow	Gulf of Alaska Fiordlands	Northern Gulf of Alaska Fiordlands
	Gulf of Alaska Forelands	Northern Gulf Forelands

Within these general categories, the Chugach National Forest can be further divided into four general ecological regions (Figure 3-3a). Within the general ecological regions are listed the ecological sections of Davidson (1996) (Figure 3-3b).

The Chugach National Forest plays a unique role in providing habitat for a wide range of wildlife species. This diversity ranges from marine mammals and seabirds to neotropical migrants and mountain goats. The three distinct geographical areas on the forest, the Kenai Peninsula, Prince William Sound, and the Copper River Delta, all have integral roles in the ecosystem processes taking place in Southcentral Alaska. The 5.49-million-acre landscape is composed of glaciers and ice fields, major glacially-fed rivers and outwash plains, steep, rugged mountain sideslopes, rolling hills, temperate rainforests, and over 4,700 miles of shoreline.

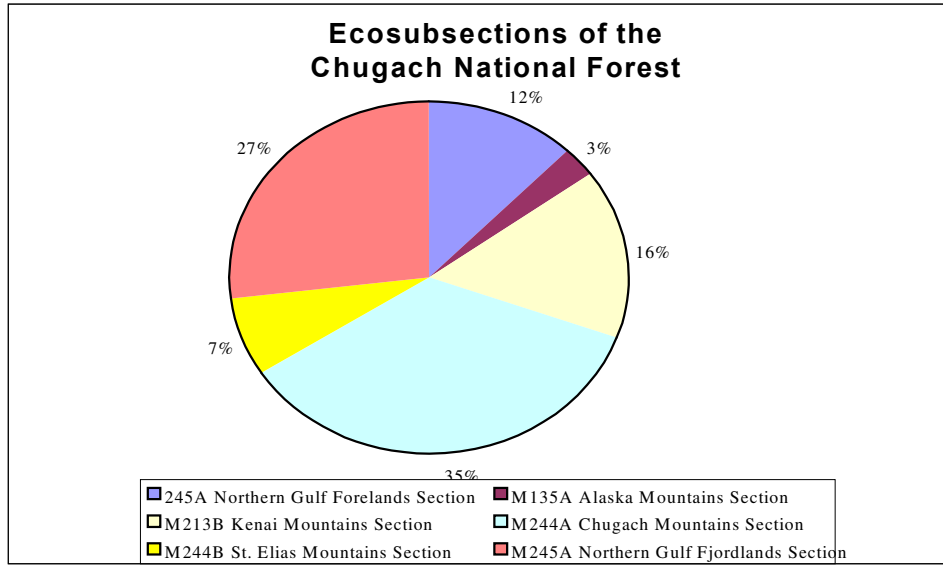
Wildlife species were evaluated to identify those species associated with the land cover types that occur within the forest (coarse filter) and were also evaluated to identify those most sensitive to reasonably foreseeable land management actions (fine filter).

Figure 3-3a: Ecological regions of the Chugach National Forest (CNF lands only).



Source: Chugach National Forest GIS corporate database.

Figure 3-3b: Ecological sections of the Chugach National Forest (CNF lands only).



Source: Chugach National Forest GIS corporate database.



Habitat Diversity

Land Cover

There is a wide range of forested and unforested habitats on the Chugach (DeVelice et al. 1999b; Boggs 1996, 2000), proportions of which vary by ecological region (Table 3-11). The Chugach and St. Elias Mountains and Icefields regions are dominated by ice, snow, and rock, with lower proportions of herbaceous alpine and subalpine vegetation. The Gulf of Alaska Fiordlands and Forelands are both dominated by closed needleleaf conifer forests and tall shrubs (primarily alder).

Table 3-11: Percent land cover classification of the Chugach National Forest by ecological regions.

Land Cover Class	Chugach Mountains	Gulf Fiordlands	Gulf Forelands	St Elias Mountains
Forest-Needleaf-Closed	4.23	30.08	22.15	1.27
Forest-Needleaf-Open	0.52	6.18	3.01	0.61
Forest-Needleaf-Woodland	0.98	5.20	0.00	0.00
Forest-Broadleaf-Closed	2.99	3.80	0.00	0.00
Forest-Broadleaf-Open	0.71	0.00	0.00	0.78
Forest-Mixed-Closed	0.23	0.04	0.00	0.00
Forest-Mixed-Open	0.08	0.04	0.00	0.00
Scrub-Dwarf Tree-Open	0.10	1.66	0.00	0.05
Scrub-Tall shrub-Closed	8.35	10.72	18.70	9.76
Scrub-Tall shrub-Open	1.75	0.77	1.87	0.17
Scrub-Low shrub-Closed	4.53	8.87	3.68	2.02
Scrub-Low shrub-Open	1.01	6.94	2.09	0.11
Herb-Graminoid/Forb-Dry/Mesic	6.74	6.12	12.90	3.71
Herb-Graminoid/Forb-Wet	0.24	3.04	10.60	1.73
Herb-Bryoid-Mosses	0.04	0.21	0.00	0.00
Herb-Bryoid-Lichens	1.02	0.00	0.00	0.00
Herb-Aquatic-Fresh	0.00	0.00	1.34	0.00
Herb-Aquatic-Brackish	0.00	0.03	0.21	0.00
Barren-Unconsolidated or Bedrock	11.10	5.02	4.44	20.00
Barren-Sand/Mud	0.43	1.60	10.72	0.22
Other-Ice/Snow/Clouds	52.74	9.56	6.10	59.14
Other-Sparsely Vegetated	2.21	0.11	2.19	0.42
Total	100.00	100.00	100.00	100.00

Source: Chugach National Forest GIS corporate and AK Department of Natural Resources databases.

The land cover classes can also be summarized by the geographic areas of the Chugach National Forest (Table 3-12). The Chugach National Forest is characterized as a land of ice and snow, needleleaf forest, and shrubs, with ice and snow making up almost 35 percent of the area. The Copper River Delta (CRD) is dominated by unforested and unvegetated cover classes, with shrubs and graminoids, the dominant vegetation classes. Forested cover types make up only 10 percent of the area. The Kenai Peninsula (KP) is characterized by alpine and subalpine conditions of ice, snow, barren, shrubs, and herbaceous vegetation classes, with almost 16 percent of the area covered by closed needleleaf and broadleaf forests. Prince William Sound (PWS) is characterized by the largest expanse of ice and snow, and the largest expanse of needleleaf forests, with almost 20 percent of the area supporting conifer stands.

Table 3-12: Percent land cover types of the Chugach National Forest by geographic area.

Land Cover Class	Copper River Delta	Kenai Peninsula	Prince William Sound	Total
Forest - needleleaf - closed	8.49	8.52	13.56	10.92
Forest - needleleaf - open	1.39	0.98	3.08	2.11
Forest - needleleaf - woodland	0.00	1.30	3.16	1.79
Forest - Broadleaf - Closed	0.00	7.24	1.72	2.37
Forest - Broadleaf - open	0.57	0.00	0.00	0.18
Forest - Mixed - Closed	0.00	0.52	0.01	0.12
Forest - Mixed - Open	0.00	0.21	0.02	0.06
Scrub - Dwarf Tree - Open	0.03	0.19	0.97	0.51
Scrub - Tall shrub - Closed	10.93	13.88	5.75	9.09
Scrub - Tall shrub - Open	0.73	4.36	0.43	1.36
Scrub - Low shrub - Closed	3.26	7.83	5.42	5.27
Scrub - Low shrub - Open	0.82	2.12	3.86	2.55
Herb - Graminoid / Forb - Dry/Mesic	6.80	12.61	4.08	6.74
Herb - Graminoid / Forb -Wet	4.63	0.06	1.73	2.27
Herb - Bryoid - Mosses	0.00	0.00	0.18	0.08
Herb - Bryoid - Lichens	0.00	2.58	0.00	0.55
Herb - Aquatic - Fresh	0.56	0.00	0.00	0.17
Herb - Aquatic - Brackish	0.08	0.00	0.01	0.03
Water - Salt - Clear	0.09	0.13	0.53	0.31
Water - Salt - Turbid	6.22	2.71	1.41	3.17
Barren - Unconsolidated or Bedrock	14.88	5.79	5.71	8.55
Barren - Sand / Mud	0.83	0.60	0.07	0.42
Other - Ice / Snow / Clouds	33.31	15.16	44.51	34.78
Other - Shadow	5.38	8.86	2.96	4.97
Other - Sparsely Vegetated	0.99	4.35	0.84	1.64
Total	100.00	100.00	100.00	100.00

Source: Chugach National Forest GIS corporate database.

Vegetative Cover

The Chugach National Forest features a wide array of vegetation diversity that includes both species poor areas and species rich areas. Data used in developing a classification of vegetation types across the National Forest (DeVelice et al. 1999a) were used to summarize this vegetation diversity. The range of vascular plant species richness (total number of species) varies from 68 in sparsely vegetated areas to 441 in shrublands (Figure 3-4a). Table L-1, in Appendix L, documents the range of species richness among community types represented by three or more plots. The range of richness varies from two species in *Puccinellia pumila* graminoid herbaceous communities to 33 in *Picea X lutzii/Equisetum arvense* open needleleaf forests. Table 3-4a also highlights the wide array of vegetation structures across the Chugach National Forest and places the Chugach National Forest vegetation types in the context of vegetation type diversity in the Alaska Region of the USDA Forest Service. The Chugach National Forest includes floristic elements transitional to the Interior of Alaska (e.g., *Picea X lutzii*, *Betula papyifera*, *Populus tremuloides*) that are not represented on the Tongass National Forest.

The DeVelice and others (1999a) study recorded 36 percent (569 species) of the total flora of Alaska (as documented in Hulten 1968). Additionally, a total of 282 community types were documented (Figure 3-4b). The greatest community

richness occurred within forest types (152) while the richness of scrub types (55) was lower than herbaceous types (75). Geographically, the number of community types varies from 122 in the Copper River Delta area to 158 in the Kenai Peninsula area of the Forest (Figure 3-4c).

Figure 3-4a: Vascular plant species richness and community richness.

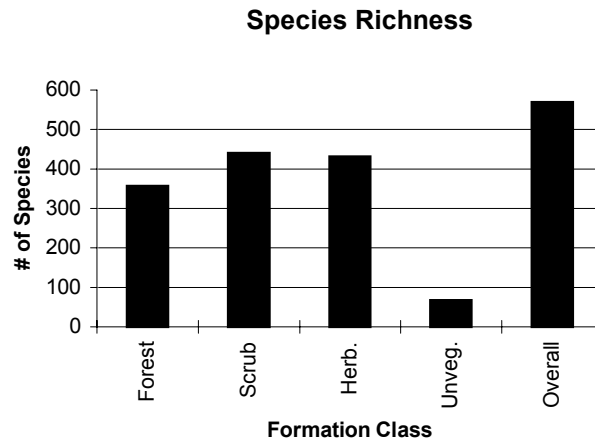


Figure 3-4b: Vascular plant community richness by formation class (i.e., level 1 of Viereck et al. 1992), and community richness.

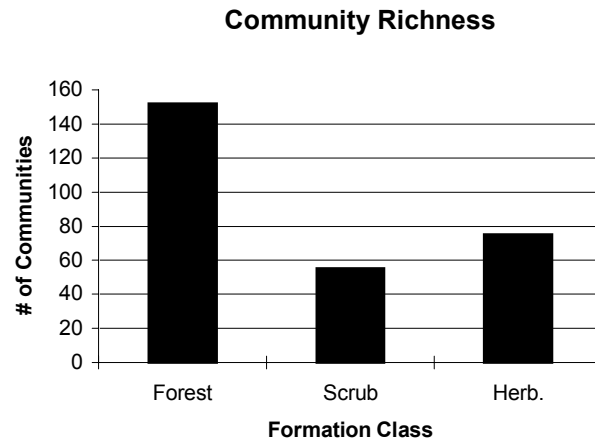
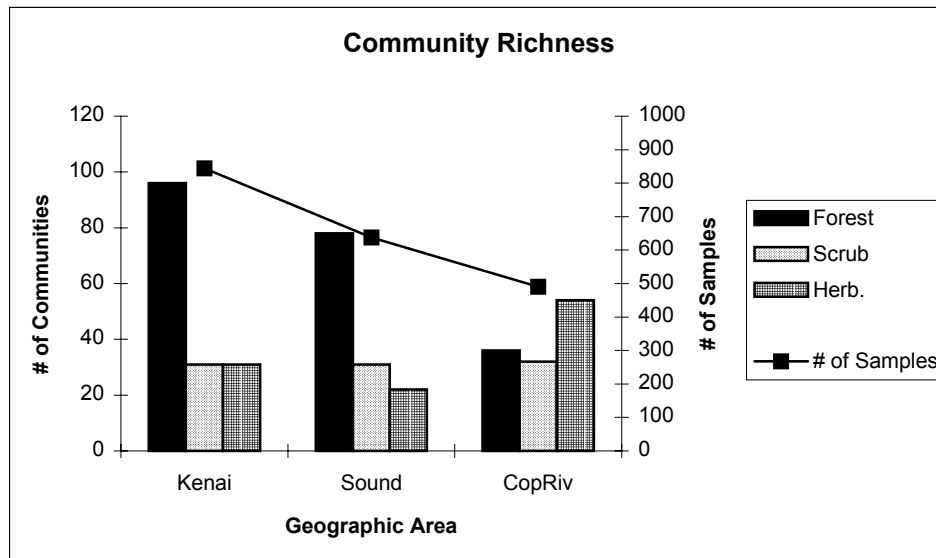


Figure 3-4c: Vascular plant species richness by formation class and geographic area (i.e., Kenai Peninsula, Prince William Sound and Copper River Delta).



The vegetation cover types of the Chugach National Forest can be further delineated by forest dominants through the use of timber and cover type classes and structure (Table 3-13). These photo-interpreted vegetation data are based on photography flown between 1950s and 1970s. (These data do not include ANILCA additions.) Hemlock and hemlock-spruce forests dominate the Chugach forest vegetation (primarily in Prince William Sound). White spruce and Sitka spruce occur less extensively, and deciduous stands of birch and aspen occur primarily on the Kenai Peninsula. Projected changes in cover types in response to spruce beetle-induced mortality and other disturbance factors between the mid 1970s and today is shown in Table 3-15. Alpine vegetation is most common on the Kenai Peninsula, while snow and ice is proportionally greatest in Prince William Sound. On the Copper River Delta willow and Sitka spruce are among the most common plant species.

Table 3-13: Percent cover types of the Chugach National Forest by geographic area (does not include ANILCA additions).

Cover Types	Copper River Delta	Kenai Peninsula	Prince William Sound	Total
Alder	7.59	11.47	0.52	5.46
Aspen	0.00	0.27	0.00	0.09
Birch	0.00	1.48	0.00	0.47
Black Spruce	0.00	0.06	0.00	0.02
Cottonwood	0.97	1.30	0.16	0.69
Grass and Alpine	7.24	26.98	4.84	12.32
Hemlock	7.10	6.64	30.17	17.88
Hemlock-Spruce	7.94	6.34	13.81	10.22
Mixed Hardwood-Softwood	0.23	1.36	0.18	0.56
Muskeg Meadow	1.82	0.22	1.56	1.19
Nonstocked	0.01	0.01	0.03	0.02
Other Brush	6.95	5.50	0.89	3.62
Other Nonforested	5.76	0.50	0.63	1.68
Rock	7.21	16.41	6.41	9.73
Sitka Spruce	9.91	0.99	2.22	3.46
Snow and Ice	10.19	13.45	36.30	23.58
Water	8.03	2.78	2.25	3.64
White Spruce	0.00	3.44	0.00	1.08
Willow	19.05	0.80	0.02	4.30
Total	100.00	100.00	100.00	100.00

Source: Chugach National Forest GIS corporate database.

Forest Structure

The forest structure of the Chugach National Forest is primarily in the old mature size class, with a significant proportion of pole timber size class as well (Table 3-14). Forest structure also varies by geographic area. The forests of Prince William Sound are almost entirely in the old mature structural class. Since the mid-1970s about 50,000 acres of forest on the Chugach National Forest portion of the Kenai Peninsula have experienced 70 percent or greater spruce mortality due to the activities of the spruce beetle (USDA Forest Service 1999a, DeLapp et al. 2000). Most of this mortality occurred to trees in the old mature class.

Table 3-14: Percent forest structural classes of the Chugach National Forest (does not include ANILCA additions and forest stands with no structural attributes).

Structural Class	Copper River Delta	Kenai Peninsula	Prince William Sound	Total
Seed/Sap	0.09	2.82	0.51	3.42
Pole timber	1.75	18.90	1.63	22.28
Young Mature	5.12	1.69	1.01	7.81
Old Mature	11.44	7.61	47.44	66.49
Total	18.40	31.02	50.58	100.00

Source: Chugach National Forest GIS corporate database.

Disturbance

The Kenai Peninsula has historically had the highest levels of disturbance, both natural and human-caused. A relatively long interval fire cycle has prevailed on the Kenai with a recurrence interval of over 500 years. While fire is not

historically frequent in the Kenai, it is much more infrequent in Prince William Sound and Copper River Delta. In the past thirty years, the Kenai Peninsula has received the greatest amounts of active management, wildfire, and bark beetle induced spruce mortality. These disturbances have caused a change in forest cover type and structure, as described in Tables 3-15 and 3-16 and Figures 3-5a and 3-5b.

The Kenai Forest Succession Model (DeLapp et al. 2000) referred to in Tables 3-15 and 3-16 and Figures 3-5a and 3-5b was developed to estimate changes in composition and structure of forest vegetation in the Kenai Mountains over the period 1875 to 2100. Spatially explicit rules were developed to extrapolate forest conditions from 1975 baseline conditions (as represented in the Chugach National Forest GIS corporate database) to pre-European settlement conditions of 1875 and current conditions of 2000. An individual tree based model (i.e., ZILIG, Urban 1990) was used to predict the annual recruitment, growth, and mortality on sites representing the range of conditions in the forested zone for the years 2000 through 2100. Outputs from the ZELIG model were used to build rules to estimate transitions from one forest type to another over time. These rules were applied in a geographic information system to map forest vegetation patterns at the landscape level for the years 2050 and 2100.

Figure 3-5b shows a 54 percent decrease in the proportion of early and mid-successional forests, and a 50 percent increase in the proportion of mature forests is predicted over the next 100 years. Broadleaf forest coverage would decrease about 4.5 percent, mixed forest area would remain stable, and needleleaf forests would increase by about 4.5 percent (Figure 3-5a). Within the needleleaf forest, the proportion of the hemlock type is projected to increase 2.5 percent while the hemlock-spruce and the spruce types would decrease about 1 and 1.5 percent, respectively (Figure 3-5a).

Table 3-15: Changes in forest cover type of the Chugach National Forest portion of the Kenai Peninsula from 1974 to 1999 (National Forest lands only).

Cover type	Acreage in 1974	Percent Forest Acreage 1974	Acreage in 1999	Percent Forest Acreage 1999	Acreage Change	Percent Change
Aspen	2,687	1.2	2,687	1.2	0	0
Birch	12,093	5.5	16,371	7.4	+4,278	+35.0
Cottonwood	14,460	6.6	14,460	6.6	0	0
Hemlock	73,287	33.3	90,281	41.0	+16,994	+23.2
Hemlock-Spruce	61,538	28	44,544	20.2	-16,994	-27.6
Mixed HW-SW	11,432	5.2	7,154	3.2	-4,278	-37.4
Spruce	44,491	20.2	44,491	20.2	0	0

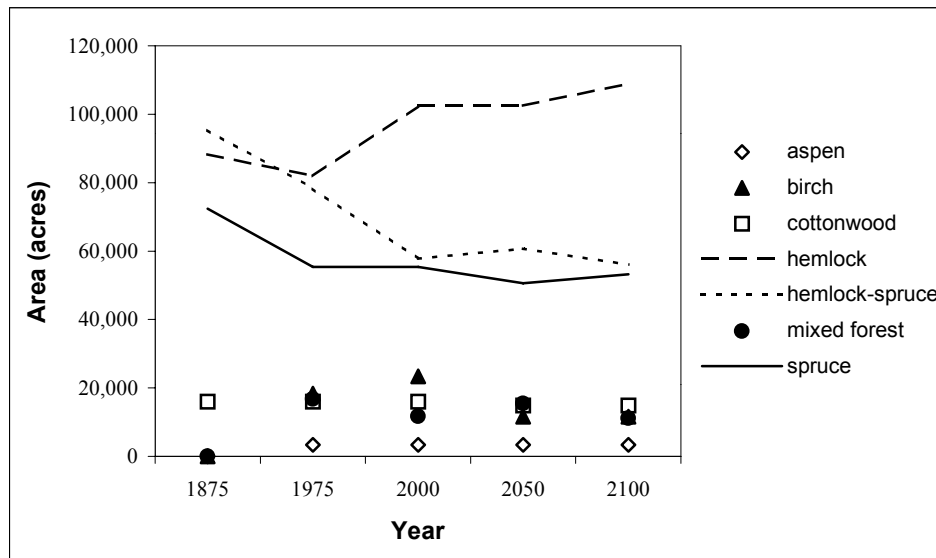
Source: Chugach National Forest GIS corporate database and Kenai Forest Succession Model (DeLapp et al. 2000).

Table 3-16: Changes in forest size class distribution of the Chugach National Forest portion of the Kenai Peninsula from 1974-1999 (NF lands only).

Structure Class	Acreage in 1974	Percent Forest Acreage in 1974	Acreage in 1999	Percent Forest Acreage in 1999	Acreage Change	Percent Change
None	42,233	19.2	39,676	18.0	-2557	-6.0
Seed/Sapling	14,494	6.6	18,795	8.5	+4301	+29.7
Pole	111,010	50.5	103,311	47.0	-7701	-6.9
Young Saw	9254	4.2	8334	3.8	-920	-9.9
Old Saw	42,997	19.5	35,298	16.0	-7699	-17.9
Standing Dead	0	0	14,574	16.6	+14574	

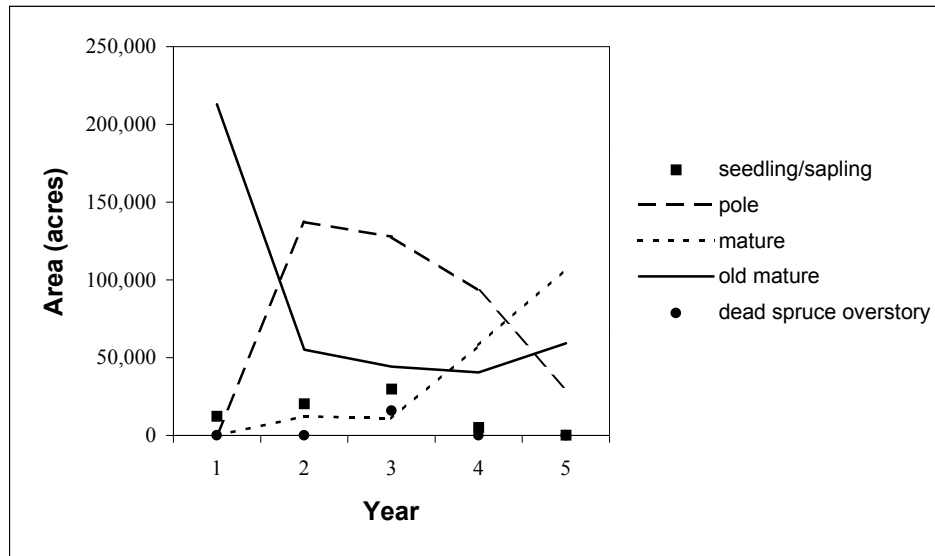
Source: Chugach National Forest GIS corporate database and Kenai Forest Succession Model (DeLapp et al. 2000).

Figure 3-5a: Area distribution of forested cover types on the Kenai Peninsula portion of the Chugach National Forest in the 1975 baseline¹ and estimated for the years 1875, 2000, 2050, and 2100 using the Kenai Forest Succession Model.



¹ Summarized from Chugach National Forest GIS corporate database.
Source: DeLapp et al. 2000.

Figure 3-5b: Area distribution of tree age classes on the Kenai Peninsula portion of the Chugach National Forest in the 1975 baseline¹ and estimated for the years 1875, 2000, 2050, and 2100 using the Kenai Forest Succession Model.



¹ Summarized from Chugach National Forest GIS corporate database.
Source: DeLapp et al. 2000.

Habitat Diversity Model

Survey data documenting the distribution of all plant and animal species across the Chugach National Forest are not presently available. The distribution of plants and animals is strongly influenced by physical environmental gradients (Whittaker 1967), which are generally specified by radiation, thermal, moisture, nutrient, and biotic regimes (Nix 1982). In the absence of distribution data for all species, specification of the dominant environmental regimes may provide surrogates for plant and animal communities and habitats (Mackey et al. 1988). The national hierarchical framework of ecological units (ECOMAP 1993) at the Landtype phase level (the smallest unit recognized in the hierarchy) would provide an effective surrogate of biological diversity at the landscape level. However, a Landtype phase level coverage across the Chugach National Forest is not presently available. To provide a summary representation of environmental regimes across the Forest, a habitat diversity model was developed by DeVelice and others (1999a) by combining the following GIS layers into a single series of 217 “bioenvironmental domains” or classes (note: the final grid used was resampled to 400 meters to create 40 acre grid cells).

- Bioclimate (BC) - grid (60 meter cell size) - described by DeVelice and Hagenstein (1995): This grid summarizes moisture, temperature, and radiation regimes. The grid was developed by extrapolating weather data from five discrete stations using the MTCLIM simulation model (Hungerford et al. 1989, Running et al. 1987) and classifying the results using a hierarchical clustering

algorithm (Belbin 1993, Belbin et al. 1992). In the application used here, the first eight cluster groups representing the range of bioclimates were used as the classes.

- Landcover characterization (LCC) - grid (30 meter cell size) - described by Markon and Williams (1996): This grid summarizes those components of the biotic regime specified by vegetation cover. The grid was developed from satellite imagery including data from Landsat thematic mapper, Landsat multispectral scanner, and SPOT multispectral scanner. The different data types were necessary to provide near-complete, cloud-free coverage of the forest. Dates of images range from August 1977 to August 1991. Image classification involved the use of standardized isodata and Bayesian classifiers (Swain and Davis 1978, Fleming 1988). The Classification used by Markon and Williams (1996) approximates level 3 of the Alaska Vegetation Classification (Viereck et al. 1992). In the application used here, the 25 classes in the Markon and Williams (1996) were aggregated into six broader classes approximating level 1 of Viereck et al. (1992), but with the inclusion of both a tall and a low shrub class.
- Landtype association (LTA) - polygon (converted to grid - using "Polygrid") - LTA classification described by Davidson (1998): This grid was used as a surrogate for nutrient regimes and as a modifier of moisture, temperature, and radiation regimes. Davidson (1998) mapped the 11 landtype association classes (8 land and 3 water classes) using air photo interpretation and topographic maps. In the application used here, the 11 classes of Davidson (1998) were aggregated into six broader classes primarily relating to mass transport (e.g., source areas such as mountain summits, transport areas such as sideslopes, depositional areas such as moraines and outwash).

This combination of climate (BC), land cover (LCC), and land form (LTA) serves as a generalized measure of the distribution of habitat types across the Chugach. These components are defined in Table 3-17.

Table 3-17: Summary description and percent coverage of the bioenvironmental components of the bioenvironmental domains of the Chugach National Forest (see DeVelice 1998 for details).¹

BC Code	Bioclimate Class Aggregate	Percent
1	Dry and mesic Copper River Delta	6.35
2	Wet and hydric Copper River Delta, hydric Prince William Sound	2.04
3	Non-hydric Prince William Sound and Glacier -	25.29
4	Non-hydric Prince William Sound and Glacier +	41.59
5	Hydric Glacier	5.50
6	Kenai -	17.28
7	Kenai +	0.35
8	Tasnuna	1.60
Total		100.00
LCC Code	Land Cover Class Aggregate	Percent
1	Forests and dwarf tree scrub	22.80
2	Tall scrub	8.90
3	Low scrub	4.88
4	Herbaceous	8.45
5	Barren	49.29
6	Water, shadow, and unmapped	5.68
Total		100.00
LTA Code	Land Type Association Aggregate	Percent
1	Glaciers	40.09
2	Mountain summits	18.41
3	Hills and mountain sideslopes	29.19
4	Depositional slopes, moraines, outwash (inc. fluvial valley bottoms)	8.46
5	Coastal	2.51
6	Water	1.34
Total		100.00

¹ The plus and minus signs of bioclimate class numbers 3 and 4 and 6 and 7 distinguish between the lower elevation conditions (-) and higher elevations (+).

The majority of bioenvironmental domain or classes occupy less than one percent of the Forest, with the ten classes with the greatest acreage occupying over 65 percent of the Forest and the remaining 207 classes occupying less than 35 percent (Table 3-18). As this table illustrates, the Chugach is a land primarily of snow and ice. The single most widespread bioenvironmental domain consists of non-hydric Prince William Sound and Glacier +, barren land cover, and glacial land type (451), occupying over 28 percent of the Forest. The most dominant vegetated bioenvironmental domain, occupying over 10 percent of the Forest, consists of non-hydric Prince William Sound and Glacier - bioclimate, forests and dwarf tree scrub land cover, on hills and mountain sideslopes land type (313).

Table 3-18: Top ten (out of 217) bioenvironmental classes of the Chugach National Forest.

#	Bioclimate Class	Land Cover Class	Land Type Association	Acres	Percent	Cumulative Percent
451	Non-hydric PWS and Glacier +	Barren	Glaciers	1,506,817	28.02	28.02
313	Non-hydric PWS and Glacier -	Forests and dwarf tree scrub	Hills and mountain sideslopes	574,812	10.69	38.70
351	Non-hydric PWS and Glacier -	Barren	Glaciers	267,013	4.96	43.67
551	Hydric glacier	Barren	Glaciers	257,104	4.78	48.45
452	Non-hydric PWS and Glacier +	Barren	Mountain summits	232,429	4.32	52.77
613	Kenai -	Forests and dwarf tree scrub	Hills and mountain sideslopes	172,475	3.21	55.98
413	Non-hydric PWS and Glacier +	Forests and dwarf tree scrub	Hills and mountain sideslopes	149,389	2.78	58.75
623	Kenai -	Tall scrub	Hills and mountain sideslopes	127,082	2.36	61.12
652	Kenai -	Barren	Mountain summits	119,423	2.22	63.34
352	Non-hydric PWS and Glacier -	Barren	Mountain summits	99,332	1.85	65.18

Source: Chugach National Forest GIS corporate database.

Expected Range of Variability (ERV)

By assessing the history of disturbance regimes on the Chugach National Forest, what ecological conditions were like in the region of the Forest before European settlement became significant in the nineteenth century can be surmised. How these conditions have changed as a result of natural and human influences in the years since the settlement period began can be recorded. Some conditions will essentially be unchanged while others may have departed significantly from earlier norms. Some conditions that had changed will have done so because such variability is natural; many ecosystems have evolved on the basis of these fluctuations. These conditions can be said to be within their expected range of variability (ERV). Other conditions will have changed, because of human intervention, to a point that is not within the range of long-term fluctuations that is natural to them. These then are considered to be outside their ERV.

The Kenai Peninsula is the focus of the following discussion on ERV since it is where the bulk of historic and proposed human activities have occurred on the Chugach National Forest. Perhaps the best available information for estimating ERV in vegetation composition over periods greater than the last 200 years are variations in fossil pollen abundances preserved in peat deposits. Vegetation composition may not be precisely inferred from pollen percentages, because of such factors as species variations in pollen production, preservation, and dispersal (Ager personal communication). However, pollen percentage data can be used to provide a general sense of trends in vegetation composition.

Within the Chugach National Forest portion of the Kenai Peninsula the only pollen record described is for a site at Tern Lake (Ager 2000b). The record for this site spans about 9,800 years when peat began accumulating after glacial ice

melted away. According to Ager (2000b) the local vegetation in the Tern Lake area today developed within the past 2,500 years. This suggests that the past 2,500 years may be a useful interval for studying the ERV in forests of the Kenai Mountains (Ager personal communication).

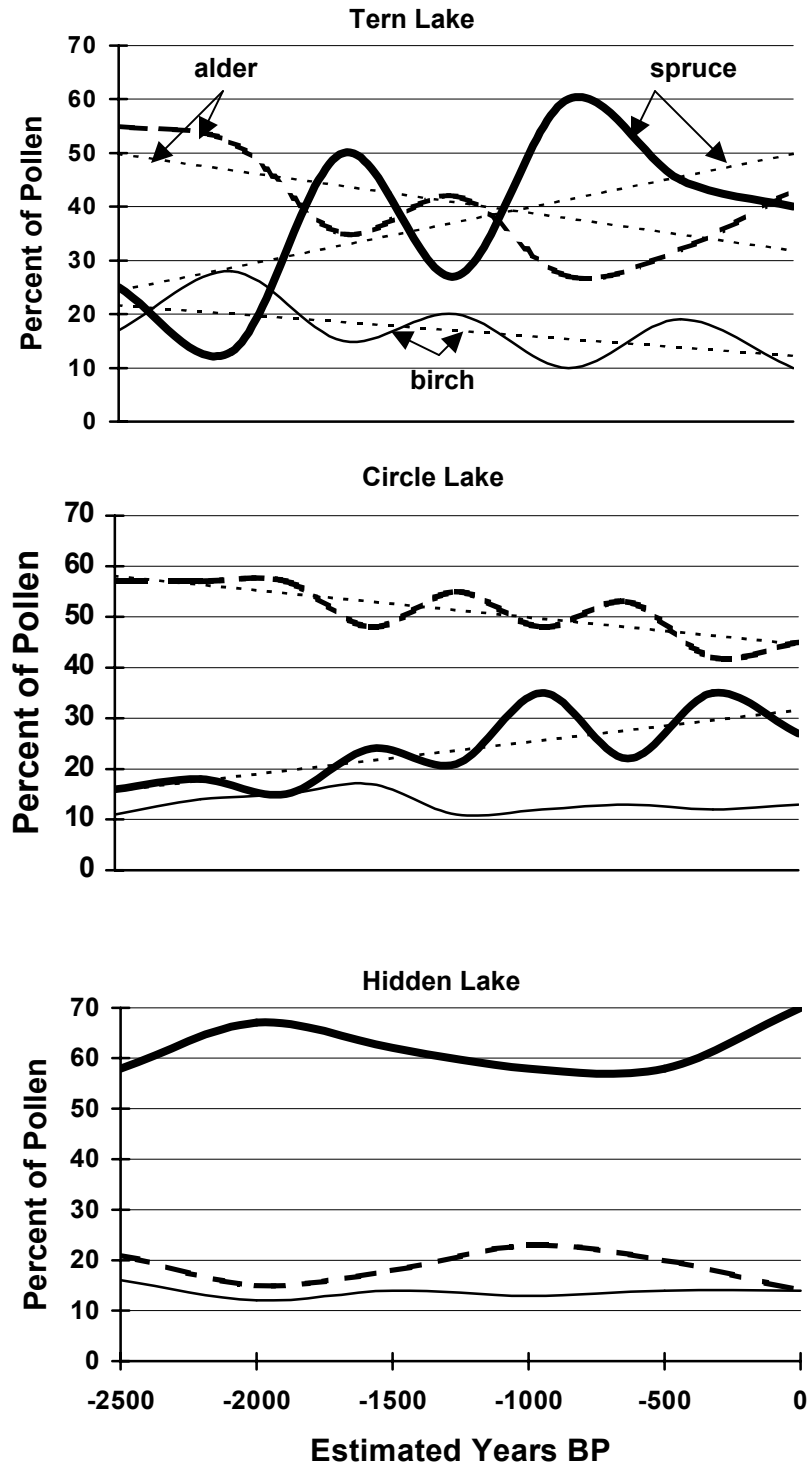
Variation in pollen abundances for sites at Tern Lake (Ager 2000b), Circle Lake near Homer (Ager 2000a), and Hidden Lake on the Kenai Lowlands (Ager 1983) are shown in Figure 3-6. Of these three sites, Tern Lake is perhaps most representative of changes occurring on the National Forest since it is the only site in the Kenai Mountains (the portion of the Peninsula where the National Forest is located). It is expected that variations in pollen abundances would occur from site to site within the Kenai Mountains and these variations may equal or exceed the variations occurring among the three sites summarized in Figure 3-6. To more accurately index ERV across the National Forest, a fossil pollen study is needed where the sample sites represent the range of conditions across the Forest.

At both Tern Lake and Circle Lake, there is a trend of increasing abundance of spruce pollen and decreasing abundance of alder pollen (Figure 3-6). Patterns of pollen abundance at Hidden Lake have been relatively stable over the last 2,500 years (although this apparent stability may be an artifact of the 10 cm sampling interval). At Tern Lake, spruce pollen abundance increases from about 25 percent 2,500 years ago to about 50 percent at present. This suggests a progressive expansion of coniferous forest into shrublands over the last 2,500 years at Tern Lake. It is suspected that this process of conifer range expansion in the Kenai Mountains is still underway (Ager personal communication).

Spruce pollen abundance at Tern Lake appears to have fluctuated markedly over the last 2,500 years (Figure 3-6). However, Ager (personal communication) cautions about over-interpreting the significance of the spruce oscillations suggested at Tern Lake since they may be an artifact of variable preservation of the pollen at the site.

In summary, based on the limited pollen evidence, the ERV of forest species abundance is high. The ERV includes both long periods (>500 years) of shrub dominance and long periods of conifer dominance. In the first decade, a total of about 36,000 acres of vegetation treatment (about 27,000 acres of which is prescribed burning) would occur under the Preferred Alternative. This acreage represents less than 5 percent of the vegetated land on the National Forest portion of the Kenai Peninsula, and less than one percent of the entire area of the National Forest. It is logical to infer that the magnitude of the ERV greatly exceeds the magnitude of proposed vegetation treatments under the Preferred Alternative, i.e., the proposed treatments are within the ERV.

Figure 3-6: Pollen percentages over approximately the last 2,500 years from sites at Tern Lake, Circle Lake and Hidden Lake (summarized from Ager 2000b, 2000a, and 1983, respectively). The fine dashed lines shown are trend lines. The Tern Lake data are based on samples at 5 cm intervals while samples at Circle and Hidden lakes were at 10 cm intervals.

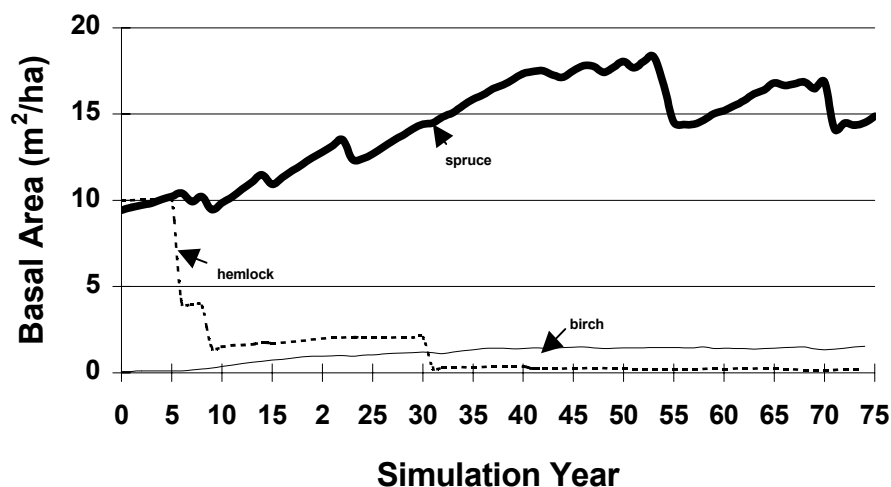


Given the prospect of global climate change (Berg and DeVolder 2001) it is uncertain whether the gradual trend of forest expansion will continue. To predict potential forest changes at a site in response to global climatic change a succession model (i.e., ZELIG, Urban 1990) was used. ZELIG is an individual tree based model that tracks the annual recruitment, growth, and mortality of individual trees at discrete sites. Annual changes are simulated by calculating the growth increment of each tree, tabulating the addition of new saplings, and tabulating the death of trees. These processes are all stochastic functions in the model.

Output from ZELIG for a site at 1,000-foot (300 meter) elevation in the Kenai is shown in Figure 3-7a. In this simulation, temperatures were increased instantaneously from a maximum of 7°C in January to a minimum of 1°C in June. The magnitude of these changes is representative of climatic changes predicted by general circulation models. However, such an increase in temperature would more realistically be expected to increase gradually rather than instantaneously. Thus, the projections of Figure 3-7a likely show a much more rapid change in composition than would actually occur.

The most striking feature of the predictions shown in Figure 3-7a is a large drop in hemlock basal area. Basically, the model predicts the more cold demanding hemlock would become a minor component of the simulation stand after a drop from co-dominance with spruce. In contrast, in climate change simulations for higher elevations (e.g., 3,000 feet), hemlock occurrence expands as temperatures that were previously too cold become favorable.

Figure 3-7a: Predicted changes in tree basal area in response to climatic change for a site in the Kenai Mountains at 300 meter elevation, on a westerly aspect with a slope of 25 percent.¹



¹ The initial hemlock-spruce stand composition is from field data. Mean monthly temperatures were increased instantaneously at the start of the simulation from a maximum of 7°C in January to a minimum of 1°C in June.

Wildlife

The range of one bird species (Kenai song sparrow) and seven subspecies of mammals (one extinct) are restricted to the Kenai Peninsula. One subspecies occurs primarily on the Kenai Peninsula, but its range extends to Palmer, Alaska. Three subspecies of small mammals are restricted to the islands and mainland of Prince William Sound.

One subspecies of gray wolf (*Canis lupis alces*), from Kachemak Bay, Alaska, is now extinct, and caribou were extirpated from the Kenai Peninsula and were reintroduced. The Montague Island hoary marmot has not been observed since the mid-seventies, and no specimens have been collected since the initial collections near the turn of the century.

Mink and deer were introduced onto islands in Prince William Sound, and moose were introduced to the Copper River Delta.

Wolves were historically absent or very rare on the Copper River Delta until the early seventies. The wolves have established a small population on the Copper River Delta.

Wolves and caribou on the Kenai Peninsula are at the lower range of ERV. Dall sheep, moose, and mountain goats are within the ERV on the Kenai.

Human uses

Modern settlement within the boundaries of the Chugach National Forest, which became significant during the latter half of the nineteenth century, significantly changed some Chugach ecosystems, particularly due to anthropogenic wildfires within the forested zones of the Kenai Peninsula. Much of terrestrial areas of Prince William Sound and the Copper River area have received minimal human impact to the present day. Prior to the nineteenth century, human impacts on ecosystems are considered to have been limited.

Fires, mining activities, logging, and railroad construction changed vegetation patterns during the early twentieth century on the Kenai Peninsula. Fire suppression during the latter half of the twentieth century has limited the extent of recent wildfires.

Forested and Nonforested Vegetation

Forest composition is within ERV except within localized, heavily managed areas such as road corridors.

On the Kenai Peninsula there is a history of long interval large stand replacing fires (Potkin 1997). Immediately prior to European settlement forests on the Kenai were dominated by mature stands of hemlock and spruce, with deciduous stands of a more limited extent than the present day (Langille 1904, Potkin 1997).

The Copper River Delta has a long history of tectonic activity, with a record of long interval localized uplift and/or subsidence. Most recently, the 1964 Good Friday Earthquake caused areas of the Delta to uplift up to eleven feet, resulting in a change in vegetation from open grass dominated communities to a greater proportion of shrub and tree species.

Since data describing forest structural changes across the last 2,500 years are not available, it is uncertain how existing forest structure compares to the ERV. However, the large changes in vegetation composition documented across the last 2,500 years at the Tern lake site on the Kenai Peninsula (Figure 3-6, Ager 2000b) likely correspond to a large range in forest structures over the ERV period. This suggests that present forest structure is within the ERV. The current extent and composition of non-forested vegetation is within the ERV.

Climate

In a climatic change study conducted at Kepler Lake (about 50 miles north of the Kenai Peninsula), three distinct climatic periods are described spanning about the last 2,500 years (Forester et al. 1989). Relative to today, a warmer and perhaps seasonally drier period occurred from about 2,500 to 750 years ago, a colder and perhaps drier period occurred between 750 to about 140 years ago, and the present climatic conditions have been in effect from 140 years ago to today. Given this variability over the last 2,500 years, precipitation, snowfall accumulation and temperatures on the Chugach National Forest are likely all within ERV. However, anecdotal evidence of drying lakes on the western Kenai may indicate possible long-term trends of warmer and drier weather (Berg personal communication).

Fire

Because of the rarity of lightning strikes on the Chugach National Forest, natural fires are rare (Potkin 1997). However, with the increase in human activity on the Kenai Peninsula portion of the National Forest near the turn of the 20th century, widespread fire disturbance occurred since that time. In fact, an estimated 1,400 fires have burned a combined 75,000 acres on the Kenai Peninsula portion of the Forest from 1914 to 1997 (Potkin 1997). Human-caused ignitions account for over 99 percent of these fires. This suggests that the current frequency of fires is in excess of the ERV.

While rare, natural fires did occur on the Kenai Peninsula portion of the Forest before the turn of the 20th century. Radiocarbon dates of charcoal samples from soils at scattered locations in the Kenai Mountains ranged from 3,010 to 570 years before present with an average of 600 years between dates (Potkin 1997). Charcoal has been reported as present in most soil pits within the forested zone

in the Kenai Mountains (Davidson personal communication). This suggests the occurrence of widespread, yet infrequent, fires in prehistoric times. The extent of fires may be at the lower end of the ERV due to fire suppression efforts controlling many of the fires, which would have burned more acreage without human intervention.

As a result of the current spruce beetle infestation in combination with fire suppression, the accumulation of litter, standing dead trees, and downed material in many spruce stands on the Kenai Peninsula portion of the Forest may be at the high end of the ERV.

Insects and diseases

Spruce beetles were almost certainly an important component of the spruce forests of the Kenai prior to European settlement. Since the mid 1970s, almost 25 percent of the forest area on the Kenai Peninsula portion of the Chugach National Forest has experienced 70 percent or greater spruce mortality as a result of spruce beetle activity. Data describing spruce beetle population fluctuations across the last 2,500 years are not available, so it is uncertain how the extent and intensity of the existing outbreak compares to the ERV. However, the large changes in vegetation composition documented across the last 2,500 years at the Tern Lake site on the Kenai Peninsula (Figure 3-6) suggests that present forest composition, as affected by the spruce beetle, may be within the ERV (Ager 2000b).

One means of examining the ERV on the Chugach National Forest is to compare the proportion of land cover classes within the perimeter of the Forest boundary with those classes occurring only on Chugach National Forest lands (Table 3-19). The proportion of land cover classes is not significantly different on and off National Forest System lands within the Forest boundary. There is slightly more closed needleleaf forest on non-National Forest lands within the Forest boundary than on National Forest lands. This is due primarily to the fact that most land exchanges have taken place within this vegetation zone, such as along the Seward Highway on the Kenai Peninsula. However the proportion is slight. In large part, the land cover of the Chugach National Forest does not differ from the land cover on lands of other ownership within the Forest boundary.

Table 3-19: Area and proportion of land cover types within the perimeter of the Chugach National Forest boundary – a comparison of National Forest System (NFS) lands with all land ownerships including inholdings.

Land Cover Class	NFS Lands	Total w/in Boundary	Percent NFS Lands	Percent Total within Boundary
Forest - needleleaf - closed	598,470	791,770	10.92	12.56
Forest - needleleaf - open	115,680	149,280	2.11	2.37
Forest - needleleaf - woodland	97,940	121,580	1.79	1.93
Forest - Broadleaf - Closed	129,920	159,170	2.37	2.52
Forest - Broadleaf - open	9,650	24,910	0.18	0.40
Forest - Mixed - Closed	6,360	7,060	0.12	0.11
Forest - Mixed - Open	3,080	3,310	0.06	0.05
Scrub - Dwarf Tree - Open	28,070	34,400	0.51	0.55
Scrub - Tall shrub - Closed	498,150	615,540	9.09	9.76
Scrub - Tall shrub - Open	74,530	81,500	1.36	1.29
Scrub - Low shrub - Closed	288,870	330,410	5.27	5.24
Scrub - Low shrub - Open	139,840	167,530	2.55	2.66
Herb - Graminoid / Forb - Dry/Mesic	369,590	412,200	6.74	6.54
Herb - Graminoid / Forb -Wet	124,320	143,420	2.27	2.27
Herb - Bryoid - Mosses	4,620	4,770	0.08	0.08
Herb - Bryoid - Lichens	30,170	30,180	0.55	0.48
Herb - Aquatic - Fresh	9,530	9,610	0.17	0.15
Herb - Aquatic - Brackish	1,640	1,790	0.03	0.03
Water - Salt - Clear	16,760	23,560	0.31	0.37
Water - Salt - Turbid	173,930	202,480	3.17	3.21
Barren - Unconsolidated or Bedrock	468,860	519,150	8.55	8.23
Barren - Sand / Mud	23,010	23,660	0.42	0.38
Other - Ice / Snow / Clouds	1,906,720	2,043,200	34.78	32.41
Other - Shadow	272,340	302,930	4.97	4.80
Other - Sparsely Vegetated	89,700	101,760	1.64	1.61
Total	5,481,750	6,305,170	100	100

Wildlife

Habitat Classification and Scoring

Changes in biodiversity for wildlife can frequently be characterized as a gradual and incremental fragmentation of habitats where no single management decision causes significant harm, but the cumulative impact of many decisions contributes to a viability concern. A comparison of wildlife habitat distribution to land ownership patterns and stewardship at a variety of landscape scales was used to assess the amount of responsibility for management of the wildlife habitat in relationship with other land stewards of the area who share that responsibility (Crist 2000).

The coarse filter analysis for wildlife first looked at the distribution of land ownership within the ecoregions and used different landscape scales down to the Forest level, to put the Chugach into context within the landscape. Following the ecoregions analysis, the distribution of wildlife species within the Forest by using land cover classifications and habitats of special interest were determined. The species richness of habitat use by wildlife species to the relative degree of management commitment to maintaining biodiversity within the Forest at multiple landscape scales was compared.

A crosswalk of Forest Management Prescriptions Categories to the land the protection status of Duffy and others (1999) was developed. Using this protection scheme allowed us to classify species richness according to prescription category, with Category 1 and 2 prescriptions corresponding roughly to the “protected” status, (protection Status 1 and 2 of Duffy and others (1999)). The more “multiple use” prescription Categories 3, 4, and 5 offer “moderate” levels of protection to ecosystem processes and the diversity of native species (protection Status 3 of Duffy and others (1999)). A review of the literature was conducted for nearly all of the species and subspecies listed in Suring and Murphy (1998) as present on the Chugach National Forest. Two mammal species and eleven bird species were not described. Habitat use by each species was reviewed. For birds, the use of habitat was classified for breeding, migration and winter season. Mammal and amphibian habitat requirements were classified for breeding and winter seasons.

Potential wildlife habitat for each species was determined using Forestwide land cover classifications. The following habitats were also used to determine species richness in those habitat areas not well represented using the land cover classification: Alpine, Beach and Tideflat Coast, Beach Fringe, Estuarine, Limnetic Lacustrine, Littoral Lacustrine, Palustrine, Riparian, Rocky Coast, Sheltered Inshore Waters and Subtidal/Intertidal.

The vegetation patterns of the Chugach are very heterogeneous. At the landscape scale, the diversity of landforms and drainage patterns influences vegetative cover: peatlands (muskegs) are characteristic of poorly drained soils; conifer forests of well-drained soils, sparse “scrub” forests of intermediate areas; and, broadleaf forests indicators of early succession following fires or other disturbances like wind or avalanches. At a smaller scale, similar vegetative patterns are common, with small patches of poorly drained non-forested areas found within mature or old growth forests for instance, or a large stand of trees in riparian soils within a larger area of wetland. The mix of land cover classes and seral conditions are important to the overall diversity of habitats.

Landscape Position. Where the vegetation occurs on the landscape is also an important component of bird and mammal biodiversity. The landscape positions and proximity to fresh or salt water are described below. These habitat areas are referred to as habitats of special interest.

Freshwater. The freshwater/vegetation interface is an important biodiversity component. These areas are associated with small wetlands and lakes including the shorelines. Littoral wetlands are represented by an approximate 50-foot buffer lakeward of the shoreline.

Alpine. These are all upland areas over 1,500 feet in elevation, excluding the beach and estuary fringe and riparian zones.

Riparian. These are a minimum of 100-foot-wide zone along both sides of all inventoried streams, excluding the beach fringe. The riparian areas adjacent to anadromous streams are thought to play a significant role in the transfer of nutrients from the marine to terrestrial ecosystems.

The following landscape positions apply to the salt-water shorelines. These areas are often forested and are thought to be important as wildlife travel corridors, transition zones between interior forests and salt-water influences, and also as a unique habitat or microclimate. The adjacent forest and freshwater location and beach substrate provides important horizontal or low-elevation connectivity between watersheds, many of which have very steep sides and/or non-forested ridge tops.

Beach Association. Beach and Estuary Fringe are represented by an approximately 1,000-foot (300 meter) buffer inland from the coastline. The Beach Fringe, Beach and Tideflat Coast, in conjunction with riparian areas, provide connectivity within watersheds. These areas are a major component of the travel corridors used by the many associated wildlife species. These areas also provide critical seasonal feeding and resting habitats for avian migrants, particularly the neo-tropical migrants.

Rocky Coast. This zone is composed of bedrock, and may provide a variety of substrate conditions depending on the exposure to prevailing winds and wave action. In these locations, there is strong vertical zonation of intertidal biological communities; species density and diversity vary greatly, but barnacles, snails, mussels, and macroalgae dominate. There is a great diversity of birds and mammals that use these areas.

Sheltered Inshore Waters. These areas are characterized as having little vegetation. However, due to the soft sediment deposits, there can be large concentrations of shellfish, polychaetes and snails in and on the sediments. These areas provide feeding and resting habitats for approximately 20 percent of the birds and mammals on the Forest.

A value from 0 – 3 (Table 3-20) was assigned to each habitat type by season (mammals and amphibians – summer/winter; birds – summer/migration/winter). If a species received all 0s during a given season, it is not known to exist on the Chugach that time of year. For the analysis, 0 - no value, 1 - low value, 2 – moderate value, and 3 – high value were considered. Each species was assigned a rating system value for each land cover classification and for each habitats of special interest. The values were recorded by species and habitat in a spreadsheet matrix. These values were also used to create Geographic Information System (GIS) files that were used to spatially array the values of the habitats associated with each species.

Table 3-20: Rating system used for scoring habitat types in species diversity matrix.

0 = Nothing in the literature suggests that the species will use this habitat.
1 = The species rarely uses this habitat, or inferences were made from the literature that the species could be using this habitat.
2 = The species uses this as habitat for feeding, refuge, or as a secondary breeding habitat.
3 = The species requires this habitat for multiple aspects of its life cycle: breeding, feeding, and refuge.

Of 244 species identified by Suring and Murphy (1998), only 231 were included in the matrix. Two mammal species and eleven bird species were not described. The first mammal is an extinct subspecies of gray wolf (*Canis lupis alces*) from

Kachemak Bay, Alaska, and the second is the northern fur seal (*Callorhinus ursinus*). The fur seal breeds in remote rookeries on the Pribilof Islands and is highly pelagic the rest of the year in the Gulf of Alaska and coastal waters of western North America. It is only a rare or accidental visitor to the Forest's coast. Eleven species of pelagic seabirds were also removed from the list. These species primarily occur in inshore and offshore waters of Prince William Sound and the Gulf of Alaska or are accidental visitors. They do not breed on National Forest lands. Many of them breed in the southern hemisphere and are only common in the offshore waters of Alaska during the summer months. The Forest does not directly provide habitat for these pelagic species, pending settlement of disputed saltwater ownership.

This species rating system allowed us to begin to quantitatively describe the habitats available for use by wildlife species on the Forest.



Analyses were made of potential species diversity by habitat type (landcover classification) and season. Table 3-21 shows the numbers of species that use the land cover classes and habitats of special interest by season. Wildlife use of the various land cover classes and habitats of special interest varies seasonally, and all habitat types are important habitats for wildlife sometime during the year.

Table 3-21: Numbers of species using the land cover classes and habitats of special interest by season.

Land Cover Class	Summer No. of Species	Summer % total species	Migration No. of Species	Migration % total species	Winter No. of Species	Winter % total species	Total No. of Species	Total % total species
Forest Needleleaf Closed	56	24	29	13	43	19	61	26
Forest Needleleaf Open	92	40	44	19	66	29	99	43
Forest Needleleaf Woodland	103	45	54	23	56	24	114	49
Forest Broadleaf Closed	34	15	15	6	26	11	40	17
Forest Broadleaf Open	62	27	29	13	40	17	70	30
Forest Mixed Closed	56	24	28	12	42	18	57	25
Forest Mixed Open	89	39	43	19	57	25	89	39
Tall Shrub Closed	31	13	25	11	18	8	42	18
Tall Shrub/Dwarf Tree Open	54	23	34	15	31	13	66	29
Low Shrub Closed	36	16	15	6	16	7	41	18
Low Shrub Open	77	33	30	13	33	14	86	37
Herb-Graminoid/Forb Dry/Mesic	61	26	27	12	28	12	71	31
Herb/Graminoid/Forb Wet	80	35	36	16	21	9	89	39
Herb/Bryoid/Mosses/Lichens	48	21	17	7	26	11	53	23
Sparsely Vegetated	35	15	14	6	15	6	46	20
Subtidal/Intertidal Estuarine	42	18	68	29	37	16	85	37
Limnetic Lacustrine	20	9	20	9	4	2	30	13
Littoral Lacustrine	62	27	38	16	13	6	76	33
Palustrine	92	40	55	24	26	11	106	46
Alpine	61	26	13	6	23	10	64	28
Riparian	87	38	48	21	41	18	96	42
Rocky Coast	23	10	21	9	18	8	33	14
Beach and Tideflat Coast	26	11	38	16	20	9	52	23
Beach Fringe	37	16	34	15	19	8	50	22
Sheltered Inshore Waters	25	11	36	16	34	15	47	20

Species associated with these landcover types require or use the type for one or more life functions, such as breeding, feeding, and refuge (i.e., species rated with 2s and 3s in the matrix).

Additional species on the Forest use these cover types only rarely or it was inferred from the literature that they could be using them (i.e., species rated with 1s in the matrix). These species were not included in the analysis for that LCC type.

There are numerous species associated with inshore and offshore waters of Prince William Sound and the Copper River Delta that do not use tidal or upland habitat and were not included in the matrix. (11 bird species, 1 marine mammal (accidental))

Land Cover Classes and subclasses from Markon and Williams. 1996.

Land cover classes and habitats of special interest were aggregated to portray species richness of general habitats of the Forest. Table 3-22 crosswalks the fine scale land cover classes and habitats of special interest to the general habitat types.

Table 3-22: Numbers of species using the land cover classes and habitats of special interest by season.

Land Cover Class	Broad Land Cover Class	Summer No. Of Species	Summer % Total Species	Migration No. Of Species	Migration % Total Species	Winter No. Of Species	Winter % Total Species	Total No. Of Species	Total % Total Species
Forest Needleleaf Closed	Forested	132	57	63	27	80	35	137	59
Forest Needleleaf Open									
Forest Needleleaf Woodland									
Forest Broadleaf Closed									
Forest Broadleaf Open									
Forest Mixed Closed									
Forest Mixed Open									
Tall Shrub Closed	Scrub	106	46	54	23	50	22	119	52
Tall Shrub/Dwarf Tree Open									
Low Shrub Closed									
Low Shrub Open	Herb-Gram-Moss-Lich	110	48	47	20	39	17	120	52
Herb-Graminoid/Forb Dry/Mesic									
Herb/Graminoid/Forb Wet									
Herb/Bryoid/Mosses/Lichens	Sparsely Vegetated	35	15	14	6	15	6	46	20
Sparsely Vegetated									
Subtidal/Intertidal Estuarine	Tidal Estuarine	42	18	69	30	37	16	86	37
Limnetic Lacustrine	Freshwater	103	45	69	30	31	13	121	52
Littoral Lacustrine									
Palustrine	Alpine	61	26	13	6	23	10	64	28
Alpine									
Riparian	Riparian	87	38	48	21	41	18	96	42
Rocky Coast	Rocky Coast	23	10	21	9	18	8	33	14
Beach and Tideflat Coast	Beach Assoc.	47	20	55	24	30	13	75	32
Beach Fringe									
Sheltered Inshore Waters	Sheltered Inshore Waters	25	11	36	16	34	15	47	20

Classes and subclasses from Markon and Williams, 1996.

Structure, for this analysis is: “the extent to which the landscape pattern of the ecosystem provides for biological flows that sustain animal and plant populations.” Two elements were considered for the analysis, fragmentation and connectivity, including corridors.

Fragmentation of habitats has been implicated in the decline of biological diversity and the ability of ecosystems to recover from disturbances (Flather et al. 1992). Habitat fragmentation is the process by which a natural landscape is broken up into small patches of natural ecosystems, isolated from one another in a matrix of lands dominated by human activities (Hunter 1996).

Fragmentation and Perforation

Fragmentation. Fragmentation is defined as the breaking out of contiguous blocks of habitat into progressively smaller patches that are increasingly isolated from one another. It may also be viewed as the process of interspersed in blocks of suitable habitat with the areas that are hostile to plant or animal life, such as highways or urban development. Fragmentation should be viewed in the concept of changes from the baseline condition some landscapes are naturally patchy while others are relatively uniform. Fragmentation factors would affect these two landscapes and the species that use them in different manners.

The assumption should not be made that the Chugach National Forest was once a vast expanse of unbroken forest. The Forest has a high degree of natural patchiness. Large-scale disturbance events such as tectonic uplift, insect epidemics, large and small-scale wind throw events, and avalanches are part of the area's natural history; coupled with slope, aspect, soil, and elevational differences, they are responsible for a diverse array of forested and nonforested landscape patterns. Moreover, these definitions do not address the question of how long these isolations last. Much other research on fragmentation has focused on changes from agriculture or urban development, which are long-term and permanent in nature. By contrast, most alterations from timber sales or other forest management activities are relatively temporary.

An important consideration is how fragmentation affects different species. Not all species of animals or plants are affected in the same way. A major highway corridor may significantly affect habitat of small mammals by bisecting it. This may have little impact on birds that can readily fly over it.

Perforation. Perforation refers to holes within otherwise contiguous blocks of habitat. An example could be a clear-cut (or group of clear cuts) surrounded by late-successional forest. These cutting units may or may not mimic natural conditions, depending upon the size and shape of cut, and many other factors. Many of the changes associated with management of National Forest System lands represent perforation rather than fragmentation of suitable habitat. They generally are not considered to be fragmentation factors in the traditional sense, and may or may not affect habitat capabilities for species.

Factors considered in this analysis included those listed below. A quantitative analysis of the patch size or fragmentation was not conducted. Since 1974 there has been a total of 7,785 acres treated on the Forest, almost 55 percent of which

was prescribed burning. The remainder, about 300 acres per year (mostly timber harvest and firewood harvest) has taken place in response to the spruce bark beetle epidemic all on the Kenai Peninsula. So very little of the management activity has contributed to changes in existing patch size.

The proposed timber harvest for Alternatives A and B and the No Action Alternative would occur within four watershed associations. Concentrating the timber harvest in these watershed associations harvests would increase effective patch size and minimize fragmentation.

The Revised Forest Plan standards and guidelines are intended to minimize the effects of timber harvest and other management activities on the pattern and connectivity of habitats. The application of these standards and guidelines is expected to result in managed stands that will have a mosaic of uneven sizes and shapes. The Revised Forest Plan standards and guidelines will also provide riparian corridors, bear-foraging buffers, and other wildlife-related buffer areas to maintain connections and remnant patches within the managed landscape.

Patch isolation/and connectivity. The creation of numerous small patches heightens the risk that suitable habitats would become isolated from each other. This problem occurs if the area between patches becomes inhospitable to species movement. Barriers to the movement of species from one suitable habitat patch to another reduce the connectivity of these habitats. When specific vegetation types and cover conditions are present between patches, species can move between them. Major sources of patch isolation that reduce connectivity include highways, construction projects on private land near the Forest, and the development recreation sites on the Forest.

Patch size. Many interior forest species seek out conditions that are beyond the influence of edges, and as such they require minimum sizes of habitat. As patches become smaller, they may not meet the needs of the species.

Edge effects. As patches become smaller, the result is an increase in the amount of edge. An impact could be increased competition and predation from species that are adapted to edge habitats. Forest vegetation management and road developments are primary factors responsible for increasing the amount of the edge within the Forest.

Among the key sources of fragmentation are the following:

The **Sterling and Seward Highways**, and private land development along them, are a major impediment to wildlife movement. These roads and urban development along them is a significant barrier to the traditional movement of moose and other species. The consistent traffic along this highway makes it difficult for large and small mammals to cross successfully. These highway

corridors have increased patch isolation and the amount of the edge, and have decreased the connectivity of suitable habitat on both sides of these roads.

Private land development in the vicinity of Moose Pass and Cooper Landing has changed much of the character of the Kenai River valley. Historical bear movement areas and moose winter range has been transformed into residential and commercial properties. This development has affected patch isolation and size, the amount of edge, and connectivity of habitats.

Active management of state and private land on the Chugach, prescribed burning, and active timber harvest, has either perforated or fragmented some portions of the landscape, depending upon the scale of development and the species involved. On the Chugach, these activities have occurred on a limited scale and species generally have suitable adjacent habitats to which they can move. Patch size may be smaller and edge amounts have increased, but for the most part connectivity has not been impaired by active management activities.

Environmental Consequences

Introduction

Timber harvests and mining activities can modify the structure and composition of native vegetation and reduce diverse natural ecosystems. However on the Chugach National Forest, such ground-disturbing management activities have been limited to a minor component of the landscape. The nature of the Chugach is one of relatively undiminished natural processes and intact ecosystems. Placer mining has altered riparian ecosystems in a few areas on the Kenai Peninsula (e.g., lower portion of Resurrection Creed). Vegetation management activities of the past 30 years have taken place primarily on the Kenai Peninsula, totaling less than 5 percent of the forested area of the Kenai. Approximately half of the area was treated by prescribed burning and half by timber harvest. The more passive management activity of increased recreational use on the Chugach poses a more subtle threat to the native flora and fauna than most active management activities. Overall, at the Forestwide level, there will be no significant effect on biodiversity under any of the alternatives.

Ecoregions of the Chugach National Forest

To better understand how Forest Plan allocation decisions would affect the regional landscape, an analysis was completed at the ecoregion scale. First, a regional landscape analysis area was identified (Figure 3-7b). The area selected was the ecoregion/subsection area developed for Forest Plan revision. This area was large enough for a regional landscape assessment and used boundaries based on ecoregions and subsections basis. This information was also used for biodiversity analysis at the Forest level.

Second, land ownership was identified for the entire regional landscape analysis area (Table 3–23a).

Table 3-23a: Regional landscape ownership.	
Owner	Acres
Chugach National Forest	5,491,600
State of Alaska	3,521,400
National Park Service	3,467,400
Bureau of Land Management	1,822,100
Native Corporations	816,900
National Wildlife Refuge	810,200
Private	170,600
Military	20,400
Total	16,110,800

Source: State of Alaska, DNR, GIS data layers.

Next, Revised Forest Plan prescription categories were assigned to all lands within the analysis area.

Category 1 – National Parks, Wilderness, Chugach State Park

Category 2 – National Wildlife Refuge, BLM Limited Use, State Wildlife/Limited Use Areas

Category 3 – BLM and State Multiple Use Areas

Category 4 – Native Corporations, Private, Military

For Chugach National Forest lands, prescription categories were used based on the Revised Forest Plan alternatives (see Chapter 2, Alternative Descriptions). Category 5 was not used because at the regional scale these areas were not mapped. Assigning prescription categories throughout the regional landscape assessment area allowed us to analyze how land allocations on the Chugach National Forest would affect the regional landscape. Table 3-23b show these effects, by Forest Plan alternative.

Table 3-23b: Percent regional landscape by prescription category, by alternative.								
Category	No Action	Preferred	A	B	C	D	E	F
Category 1	39	44	28	34	37	46	52	56
Category 2	26	36	33	37	42	35	29	25
Category 3	29	14	29	23	14	13	13	13
Category 4	6	6	10	6	7	6	6	6
Category 5	0	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100

At the regional landscape level, Alternatives A, E, and F would have a significant change (greater than ± 10 percent) in amount of lands in the preservation category (Category 1). Under Alternative A, there would be 11 percent decrease from the current condition (No Action Alternative), and under Alternatives E and F, there would be 13 and 17 percent increase, respectively. Under the Preferred

Alternative and Alternatives B, C, and D, the change in the amount preservation lands would not be significant (less than ± 10 percent).

At the regional landscape level, the Preferred Alternative and Alternatives B and C would have a significant change (greater than ± 10 percent) in the lands in the recreation/wildlife category (Category 2). Under the Preferred Alternative and Alternatives B and C there would be a 10, 11, and 16 percent increase, respectively. Under Alternatives A, D and E, the change in the amount of recreation/wildlife lands would not be significant (less than ± 10 percent). Under Alternative F, the amount of recreation/wildlife lands would not change (± 1 percent).

At the regional landscape level, the Preferred Alternative and Alternatives C, D, E, and F would have a significant change (greater than ± 10 percent) in the lands in the actively managed for wildlife/recreation and resource improvement (Category 3). Under the Preferred Alternative and Alternatives C, D, E, and F there would be a 15, 15, 16, 16, and 16 percent decrease from the current condition (No Action Alternative), respectively. Under Alternative B, the change in the amount of actively managed for recreation/wildlife and resource improvement would not be significant (less than ± 10 percent). Under Alternative A, the amount of lands actively managed for wildlife/recreation and resource improvement would not change (± 1 percent).

At the regional landscape level only Alternative A would have some change in the lands in that may be used for resource development (Category 4). Under Alternative A there would be 3 percent increase from the current condition (No Action Alternative). This change would not be significant (less than 10 percent). Under the Preferred Alternative and Alternatives B, C, D, E, and F, the resource development lands would not change (± 1 percent).

Collectively, at the regional landscape level only Alternative A would have more development (Category 3 and 4 lands) than the current condition (No Action Alternative). Alternative B would have somewhat less development than the current condition, but it would be higher than other alternatives. The Preferred Alternative and Alternatives C, D, E, and F would reduce the lands available for resource development by about 15 percent over the current condition. There are little real differences between these alternatives because they all retain about 80 percent of the lands in a preservation or limited use category.

This analysis was done at a large scale and there were some shortcomings in the available data. For example, Congress would have to act on Chugach National Forest Wilderness and Wild and Scenic River recommendations before these areas are actually protected by law. Most state and BLM lands were not stratified into different categories, so agency planners had to make their best estimates. In addition, not all native corporation and private lands would be used for resource development. Likewise, not all Chugach National Forest lands allocated for resource development would be developed. However, all these lands are available for resource development. Even with these shortcomings, this analysis allows us to identify land allocation decisions that would significantly

affect the regional landscape. However, the degree with which they would be affected by resource development most likely would be far less than projected.

Habitat Diversity

Land Cover

Figure 3-8a presents the proportion of each land cover class in each prescription category by alternative for the entire Forest (including ANILCA additions).

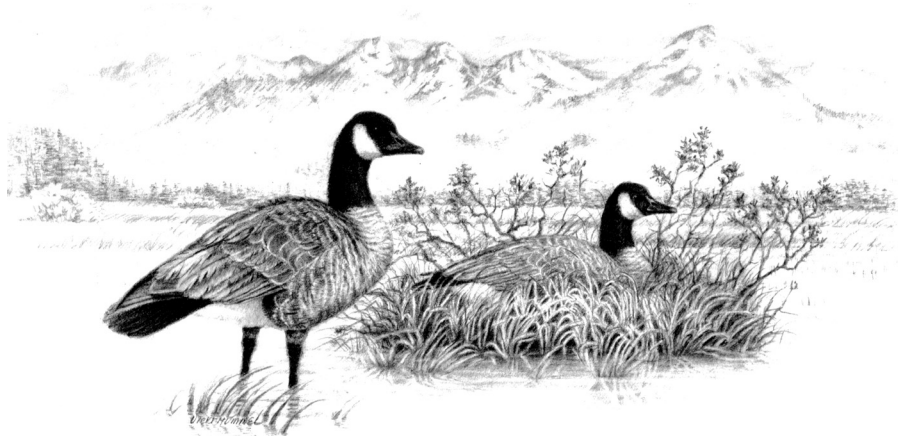
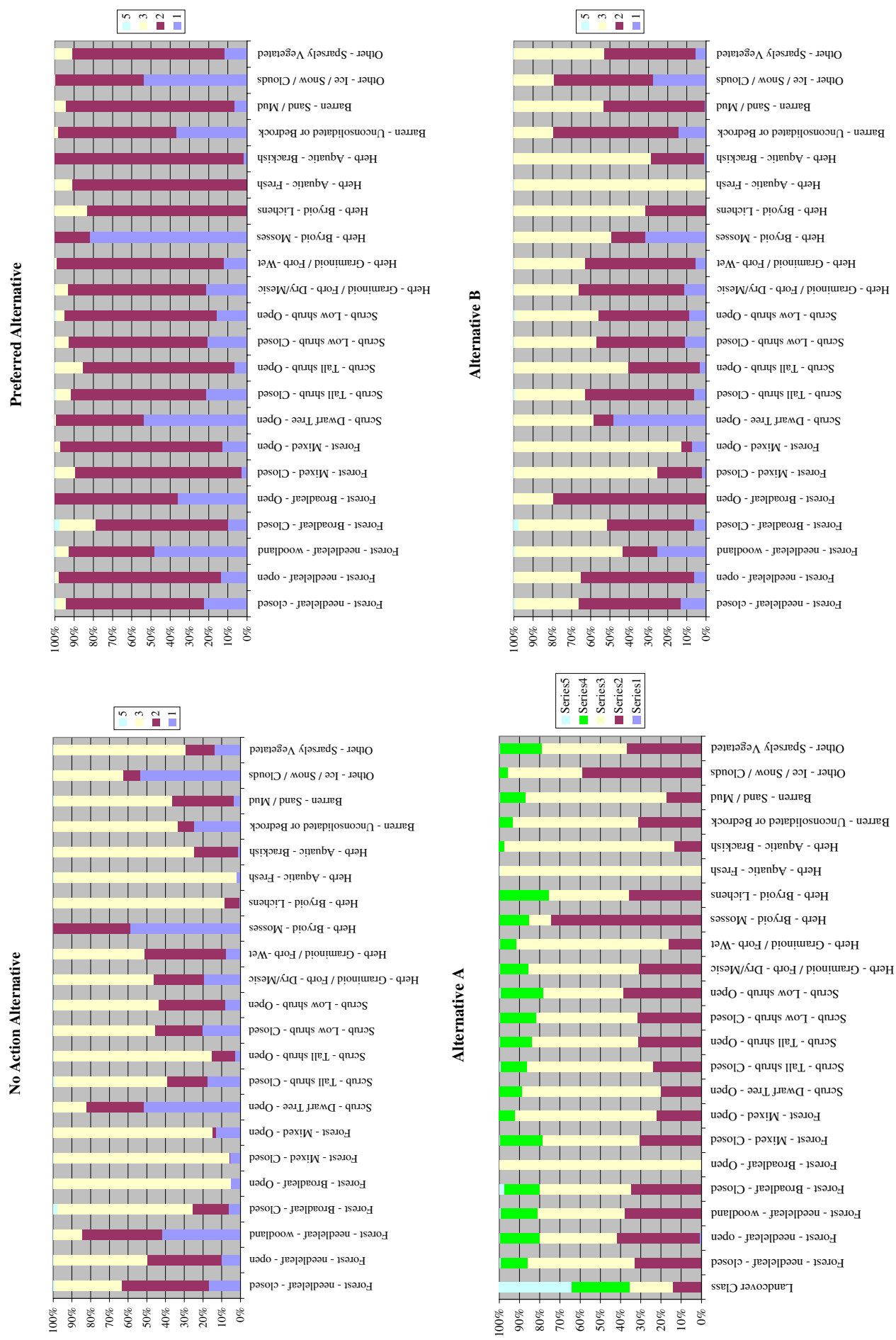
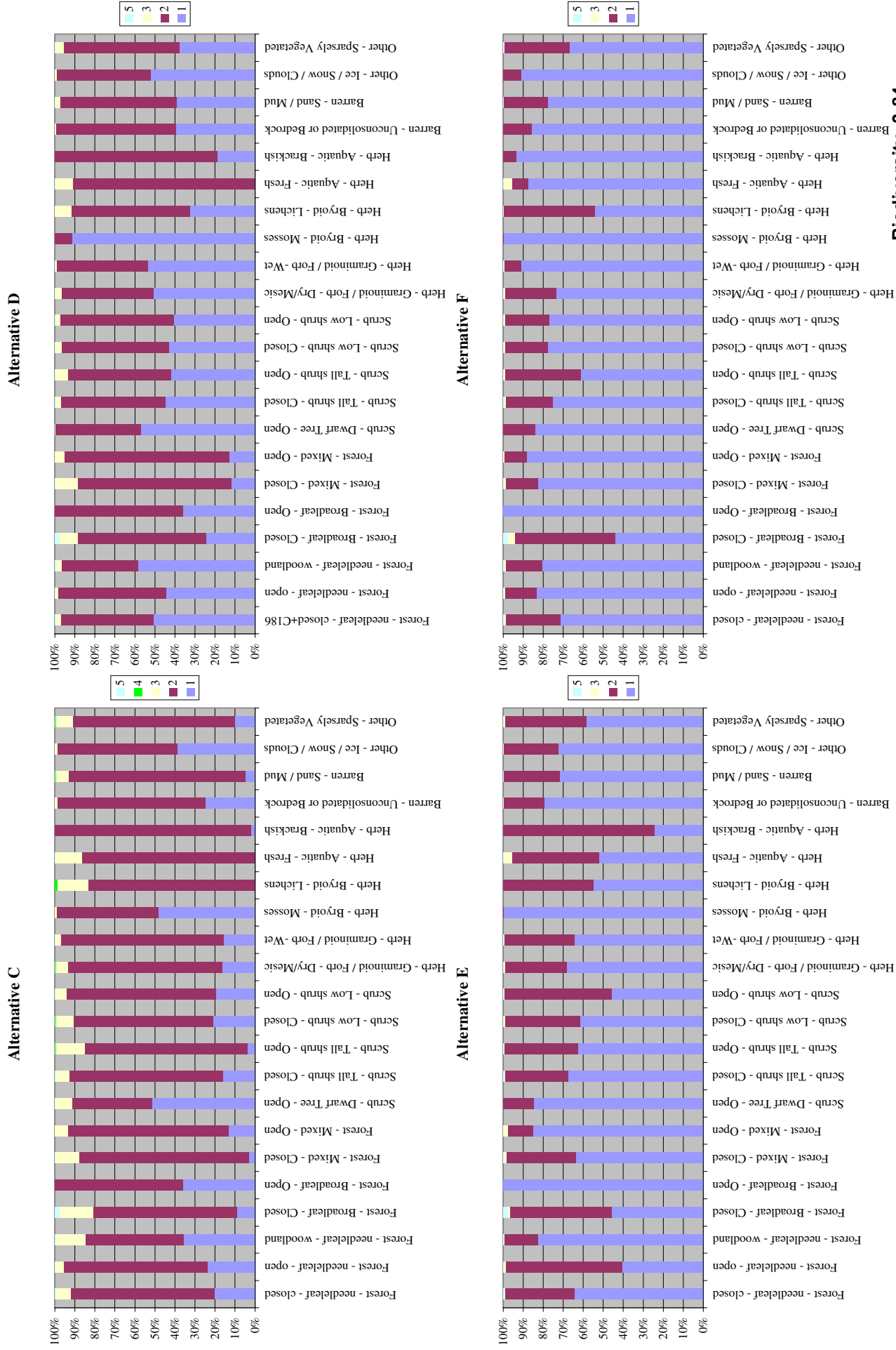


Figure 3-8a: Proportion of land cover class by prescription category by alternative.



Environment and Effects 3

Figure 3-8a (continued): Proportion of land cover class by prescription category by alternative.



Vegetative Cover

Figure 3-8b displays the proportion of land cover types of the Chugach (not including the ANILCA additions) by prescription category (1-5) for each alternative. Figure 3-8c illustrates the forest structural classes Forestwide (not including ANILCA additions) by prescription category and alternative. The greatest amount of ground-disturbing activity and associated potential for adverse impacts on biological diversity is in Category 4 and 5 prescriptions (although the threat is low in these prescriptions due to the variety of laws and regulations which protect and provide for intact ecosystems on federal lands). While Category 3 prescriptions apply a relatively soft touch on the land, some ground-disturbing activities are allowed. Category 1 and 2 prescriptions afford the highest protection of intact natural ecosystems (but may restrict management options for ecosystem restoration). However, many Category 1 and 2 prescriptions may serve to promote increased recreational activities on the Forest, causing threats to populations susceptible to increased human presence. The proportion of Category 5 prescriptions does not vary between alternatives.

The No Action Alternative includes most vegetation cover classes in Category 3 prescriptions, with significant proportions in Category 1 and 2 prescriptions. The greatest proportions of hemlock, hemlock-spruce, and Sitka spruce occur in Category 2 prescriptions. Most deciduous forest, mixed hardwood-softwood, and white spruce stands are in Category 3 prescriptions, which allows for active management in order to maintain early successional habitat and accelerate forest succession in areas of high bark beetle spruce mortality. The majority of the snow and ice cover class is in Category 1 prescriptions.

The Preferred Alternative includes almost all cover types in Category 2 prescriptions, with significant proportions of many cover classes (particularly hemlock and hemlock-spruce) also in Category 1 prescriptions. The relatively limited vegetation classes of birch and black spruce (occurring almost exclusively on the Kenai Peninsula) are primarily in Category 3 prescriptions. Significant proportions of aspen, mixed hardwood-softwood, and white spruce forests are in Category 3 prescriptions, allowing for active management in those stands in order to maintain early successional habitat and accelerate forest succession in areas of high bark beetle spruce mortality.

Alternative A includes the majority of all cover classes in Category 3 prescriptions, with the exception of snow and ice and rock classes, the bulk of which are included in Category 2 prescriptions. Significant proportions of hemlock and hemlock-spruce also occur in Category 2 prescriptions. Active management is allowed in most stands in all cover types. Alternative A allows for the greatest amount of ground-disturbing activities and motorized recreation.

Alternative B consists primarily of an almost equal proportion of Category 2 and 3 prescriptions. Sitka spruce, hemlock, and hemlock-spruce stands occur primarily in Category 2 prescriptions, while deciduous, mixed hardwood-softwood, and white spruce stands occur primarily in Category 3 prescriptions (allowing for active management of deciduous stands and bark beetle impacted spruce stands). Significant proportions of hemlock and hemlock-spruce also occur in

Category 1 and 3 prescriptions, while a significant proportion of mixed hardwood-softwood forest also occurs in Category 2 prescriptions.

Alternative C consists primarily of Category 2 prescriptions, with a lesser amount in Category 1. The most cover classes are in Category 2 prescriptions. Slightly more birch and black spruce stands are in Category 3 rather than Category 2 prescriptions. Significant proportions of hemlock and hemlock-spruce cover classes are also in Category 1 prescriptions. Significant proportions of aspen, mixed hardwood-softwood, and white spruce also occur in Category 3 prescriptions (primarily on the Kenai Peninsula), allowing for active management of deciduous forests and restoration of spruce forests with high levels of bark beetle induced mortality.

Alternative D includes almost equal proportions of Category 1 and 2 prescriptions. The majority of cover classes occur in Category 2 prescriptions, with slightly more birch and black spruce in Category 3 rather than Category 2 prescriptions. Aspen, hemlock-spruce, and Sitka spruce are primarily in Category 1 prescriptions. Significant proportions of aspen also occur in Category 2 and 3 prescriptions. Significant proportions of hemlock and white spruce also occur in Category 1 prescriptions. Those areas of aspen and birch occurring in Category 3 prescriptions would allow for active management in necessary to maintain such early successional deciduous stands. Active management would not be an option for the majority of mixed hardwood-softwoods and white spruce in Categories 1 and 2 prescriptions. The mixed stands would continue to become more dominated by conifers, while the white spruce stands impacted by the bark beetle would become reforested at a slower rate than if actively managed.

Alternative E includes the majority of all cover classes except birch in Category 1 prescriptions. The majority of birch is in Category 2 prescriptions. Significant proportions of all cover classes also occur in Category 2 prescriptions. Minimal amounts of most cover classes occur in Category 3 prescriptions. Alternative E would allow for minimal active management of the Chugach National Forest.

Alternative F includes the greatest proportion of all cover classes in Category 1 prescriptions. Most of the relatively restricted black spruce cover class occurs in Category 2 prescriptions. All the remaining cover classes occur predominantly in Category 1 prescriptions, with significant proportions of each also in Category 2 prescriptions (but less than in Alternative E). Small proportions of aspen, birch, and mixed hardwood-softwoods occur in Category 3 prescriptions would allow for limited active management of forest conditions on the Kenai Peninsula.

Forest Structure

The distribution of the different forest structure classes within prescription categories also varies by alternatives (Figure 3-8c). The majority of young mature and old mature size classes are in Category 1 or 2 prescriptions in all alternatives, except Alternative A. Most poletimber and seedling/sapling size class acreages are in Category 3 prescriptions in the No Action Alternative and Alternatives A and B. Poletimber and seedling/sapling size class acreages are

predominantly in Category 2 prescriptions in the Preferred Alternative and Alternatives C and D. Alternatives E and F have most poletimber and seedling/sapling (as well as young and old mature) size classes in Category 1 prescriptions.

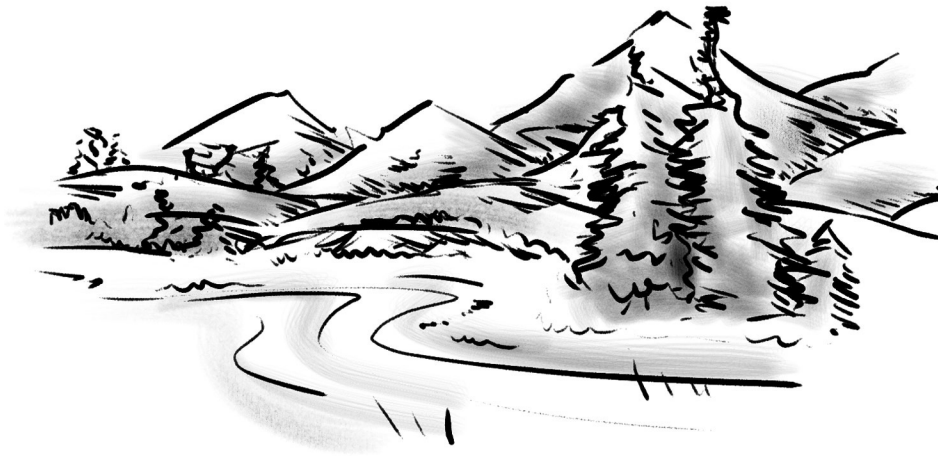


Figure 3-8b: Proportions of vegetative cover types by prescription category, by alternative (does not include ANILCA additions).

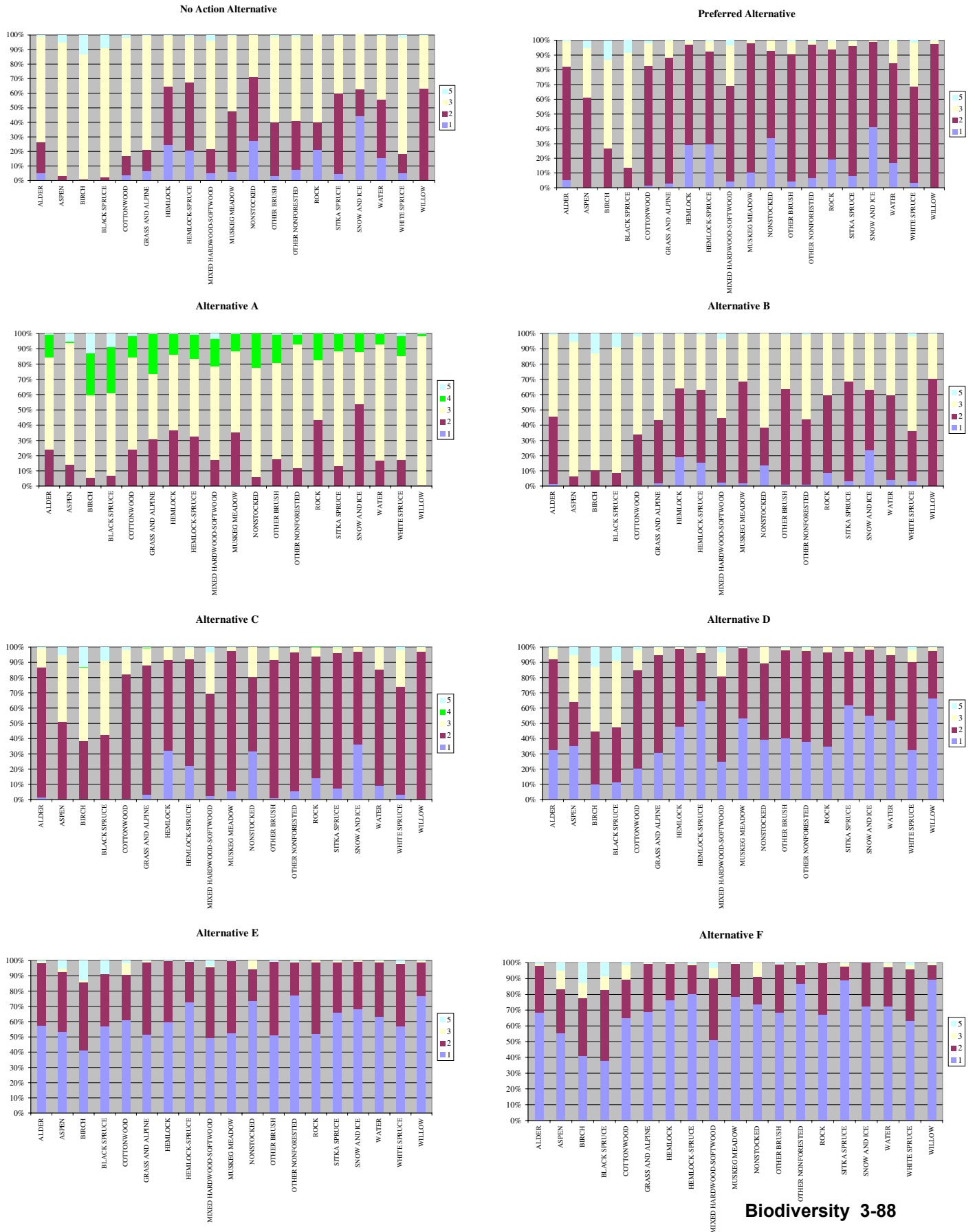


Figure 3-8c: Proportion of forest structural classes by alternative, all forest types (does not include ANILCA additions).



Habitat Diversity Model

The bioenvironmental classification of the Chugach National Forest serves as a measure of habitat diversity across the Forest. These classes can be grouped according to prescription category, with Category 1 and 2 prescriptions corresponding roughly to the “protected” status of Duffy and others (1999) (status 1 and 2 of Duffy et al. (1999)). The more active management area prescriptions Categories 3, 4, and 5 offer “moderate” levels of protection to ecosystem processes and the diversity of native species (protection status 3 of Duffy et al. 1999).

At the coarse filter level, 12 percent was considered to be a minimal representative amount of each bioenvironmental domain, based on works by Duffy and others (1999) (Conservation of Arctic Flora and Fauna 1994, World Commission on Environment and Development 1987). The Commission arrived at 12 percent by suggesting that the amount of land in reserves needed to be at least tripled to achieve a representative sample of biological diversity. In 1987, when the Commission report was published, approximately 4 percent of the world was in reserves. In the present analysis, 12 percent is used for comparisons, although it may be too low to be a valid target for representation. The proportion of the total area needed for representation of all the features of a region can be large. Estimates vary from 8 percent (Pressey and Nicholls 1989) to 45 percent (Margules et al. 1988) depending on the scale of definition of the features and the size of the area being examined (Bedward et al. 1992). Numerous factors influence the percentage of a region needed in reserves to meet conservation goals. These are listed and described in Noss and Cooperrider (1994), and include such factors as habitat heterogeneity, area requirements of the species present, scales of natural disturbance, and the degree of connectivity among habitat patches.

No Action Alternative: 65 percent of bioenvironmental classes protected at 12 percent or greater level (75 classes out of 217 with less than 12 percent of the area in Category 1 or 2 prescriptions). Total area of bioenvironmental classes with less than 12 percent area in Category 1 or 2 prescriptions is 855,134 acres.

Preferred Alternative: 99 percent of bioenvironmental classes protected at 12 percent greater level (3 classes out of 217 with less than 12 percent of the area in Category 1 or 2 prescriptions). Total area of bioenvironmental classes with less than 12 percent in Category 1 or 2 prescriptions is 458 acres.

Alternative A: 41 percent of bioenvironmental classes protected at 12 percent or greater level (127 classes out of 217 with less than 12 percent of the area in Category 1 or 2 prescriptions). Total area of bioenvironmental classes with less than 12 percent of the area in Category 1 or 2 prescriptions is 665,190 acres.

Alternative B: 85 percent of bioenvironmental classes protected at 12 percent or greater level (32 classes out of 217 with less than 12 percent of the area in Category 1 or 2 prescriptions). Total area of bioenvironmental classes with less than 12 percent in Category 1 or 2 prescriptions is 28,613 acres.

Alternatives C, D and E: 98 percent of bioenvironmental classes protected at 12 percent or greater level (4 classes out of 217 with less than 12 percent of the area in Category 1 or 2 prescriptions). Total area of bioenvironmental classes with less than 12 percent in Category 1 or 2 prescriptions is 500 acres.

Alternative F: 99 percent of bioenvironmental classes protected at 12 percent or greater level (2 classes out of 217 with less than 12 percent area in Category 1 or 2 prescriptions). Total area of bioenvironmental classes with less than 12 percent in Category 1 or 2 prescriptions is 42 acres.

Figure 3-9a displays the proportion of all bioenvironmental classes with at least 12 percent of the area in Category 1 or 2 prescriptions versus those with less than 12 percent. Figure 3-9b displays area by prescription category for those bioenvironmental types with less than the minimum 12 percent in Category 1 or 2 prescriptions. One needs to remember, biodiversity would not be affected just because lands are allocated to Category 3, 4 or 5 prescriptions. Any effects would be spaced over time as disturbance activities permitted by the management area prescriptions are implemented.

Figure 3-9a: Bioenvironmental classes with at least 12 percent of area in Category 1 or 2 prescriptions by alternative.

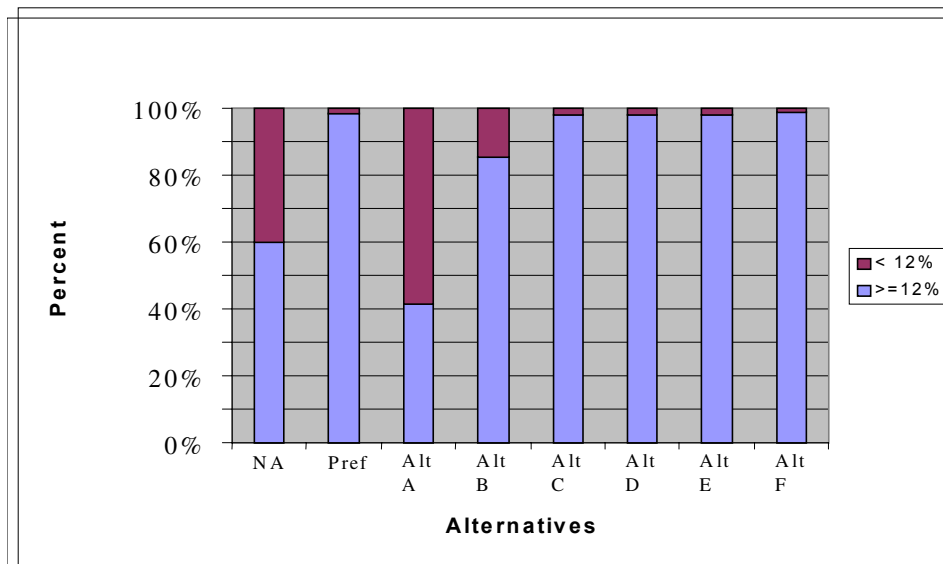
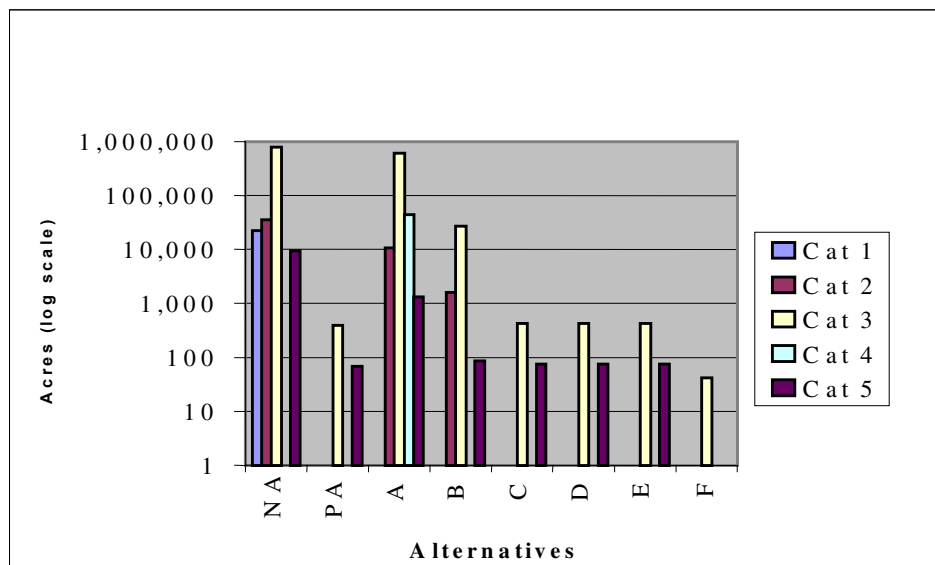


Figure 3-9b: Area of bioenvironmental classes with less than 12 percent of area in Category 1 or 2 prescriptions by alternative.



Expected Range of Variability (ERV)

General effects

Most changes to vegetation in these areas would result from natural disturbances alone, which generally would result in maintaining ERV conditions. Where active management is prescribed, changes in vegetation would occur at a site-specific scale. Most of the active management is proposed to occur on the Kenai Peninsula portion of the Forest. This is also the area where bark beetles have been most active, and where the present-day vegetation has been widely affected by human-caused disturbance (primarily burning, logging, and mining) within the last 100 years. However, as was pointed out earlier, over the 10-year life of the Revised Forest Plan, a total of about 36,000 acres of vegetation treatment would occur under the Preferred Alternative. This acreage represents less than 5 percent of the vegetated land on the National Forest portion of the Kenai Peninsula, and less than one percent of the entire area of the Forest. It is logical to infer that the magnitude of the ERV greatly exceeds the magnitude of proposed vegetation treatments under the Preferred Alternative, i.e., the proposed treatments are within the ERV, even on the Kenai Peninsula.

- The No Action Alternative emphasizes a mix of active management and natural processes with which to sustain ecological systems. Active management for the conservation of fish and wildlife habitats and active reforestation of spruce beetle infested stands on the Kenai Peninsula is emphasized.
- The Preferred Alternative stresses natural processes within the Copper River and Prince William Sound geographic areas, while

allowing some active management and/or resource development in selected areas, such as on the Kenai Peninsula. Active management is allowed in order to maintain ERV parameters such as the existing early successional conditions and to accelerate reforestation within areas of high bark beetle spruce mortality. Although tree regeneration is projected to occur within bark beetle affected areas (DeLapp et al. 2000) active reforestation may be desirable to accelerate the regeneration process.

- Alternative A emphasizes active management throughout the forest to sustain ecological systems. The reforestation of spruce beetle infested stands on the Kenai Peninsula receives particular emphasis.
- Alternative B provides for active management throughout most of the Forest in order to sustain ecological systems. The conservation of fish and wildlife habitats and active reforestation of spruce beetle infested stands on the Kenai Peninsula is emphasized.
- Alternative C emphasizes a mix of active management and natural processes throughout the Forest to sustain ecological systems. The conservation of fish and wildlife habitats and active reforestation of spruce beetle infested stands on the Kenai Peninsula is emphasized.
- Alternative D stresses natural processes over most of the Chugach National Forest, with limited active management primarily in areas adjacent to roads and in areas on the Kenai Peninsula and Copper River Delta for fish and wildlife projects, recreation facility development, and for personal uses.
- Alternative E emphasizes natural processes throughout the Forest, stressing the preservation of intact ecosystems through passive management. Reforestation activities would be restricted to the Kenai Peninsula highway corridor or around local communities, and would be limited to the salvage of dead trees.
- Alternative F emphasizes natural processes throughout the Forest to sustain ecological systems, stressing the preservation of intact ecosystems and integrity of roadless areas across the Forest. Active management activities are limited over the broadest area of the Forest. Reforestation of spruce beetle infested stands on the Kenai Peninsula would be allowed within the highway corridor and around local communities, but would be limited to the salvage of dead trees. Limited fuel reduction and wildlife enhancement projects would be allowed in the vicinity of Kenai Peninsula communities.

Effects on the ERV from utility corridors

The effects of utility corridors would be minimal on the biological and habitat diversity of the Chugach, being of very limited extent on the Forest.

Effects on the ERV from mineral exploration and extraction (leasable)

Localized modification of vegetation structure and composition would result from the construction and maintenance of roads and well pads during development and extraction, but impacts would not be significant in any alternative.

Effects on the ERV from mineral exploration and extraction (locatable)

Development of access roads and ground-disturbing mineral exploration may affect some forest stands. The potential for intensive development of locatable minerals is considered to be low for all alternatives. The greatest number of acres of mineral withdrawal occurs in Alternative F. Alternative A has the fewest acres withdrawn. No significant changes to ERV characteristics are expected in any alternative.

Effects on the ERV from recreation management

The construction of new trails may promote the introduction of noxious weeds and non-native vegetation. The greatest impacts would be in Alternatives C, B, D, the Preferred Alternative, and Alternative A, with the greatest amount of new trail construction. Alternative F would have the least potential for impacts, with the least amount of new trail construction. The No Action Alternative and Alternative E would both have moderate greater impacts with slightly more trail construction.

Effects on the ERV from timber management

The limited nature of proposed timber management in all alternatives would minimally affect the ERV through the creation of increased proportions of early seral vegetation and possible increased presence of noxious weeds in certain alternatives. Alternative A promotes the highest levels of active management and early successional forests. Alternatives A and B and the No Action Alternative all incorporate timber harvest to maintain the ERV of early seral conditions. The Preferred Alternative and Alternatives C, D, E, and F all stress the need for maintaining or enhancing ERV old growth conditions, maintaining early successional conditions through natural disturbance regimes.

Effects on the ERV from access management

Impacts to vegetation from travel management would result from habitat alterations during the construction and maintenance of roads and trails. Alternatives A (11.4 miles) and B (10 miles) result in the most miles of annual road construction, followed by the No Action Alternative. The Preferred Alternative and Alternatives C, D, E, and F have the fewest new miles (ranging from 3.3 to 1.3 per year). The overall impacts to forestwide ERV vegetation conditions are minimal due to the small acreages involved.

Effects on the ERV from fire management

Prescribed fire would be used to achieve fuels management and wildlife management goals on the Kenai Peninsula in all alternatives. Fuels treatments in forested and non-forested areas are projected for all alternatives. Fire

suppression efforts would be similar in all alternatives and would concentrate on protection of private lands and high-value resources. Impacts to ERV conditions from fire management are expected to increase early successional conditions and the extent of hardwood stands on the Kenai Peninsula. The Preferred and No Action Alternatives and Alternatives A, B and C all have approximately 2,650 acres of annual prescribed burning projected for the Kenai Peninsula. Alternative D has approximately 1,950 acres, while Alternatives F and E have the least at approximately 1,300 acres per year.

Fire management activities would preserve the expected range of variability under current climatic conditions for the results of fire. The Kenai Peninsula has historically been the most subject to wildfires of any area in the Chugach National Forest and neither the magnitude nor frequency of wildfires is anticipated to exceed those that occurred historically. The prescribed fire regime, even with happenstance wildfires, would not change the vegetative pattern beyond that in the historical record. Prescribed fire and mechanical treatments to convert vegetation to an earlier seral stage will affect, at most, 36,000 acres of the total 773,499 acres of land to which such treatments could be applied, or less than 5 percent. Large wildfires coupled with the prescribed fire regime likely would recreate conditions similar to those following the large wildfires on the Kenai prior to the 1930s. The resulting vegetation increased winter habitat for moose and other early- to mid- successional dependent wildlife species, such as snowshoe hares and their predators. Fire suppression activities would tend to restore conditions over time to those currently extant. Effects on late successional wildlife species would be no different than during the middle to late 1900s. As succession advanced, such species would either increase in numbers or recolonize the Kenai Peninsula from other areas of the Chugach National Forest that have not been affected by wildfires.

Fragmentation and Perforation

General effects

In general, the more human activities occur in an area, the greater the likelihood that habitats would become fragmented or perforated. Timber management, road and trail construction and reconstruction, mineral exploration and extraction, development, development of utility corridors, and developed recreation sites all have the potential to increase fragmentation and perforation.

Areas recommended for Wilderness designation or which are included in management areas that focus on limited active management would reduce the risk for fragmentation and perforation. Forest restoration and wildlife habitat improvement projects may include projects that could result in some level of fragmentation or perforation depending upon the habitat management techniques selected. Some level of natural fragmentation, including perforation, may result depending upon the type and extent of disturbance, the amount of adjacent suitable habitat remaining after the disturbance, and the species involved.

In areas of the Forest where management activities would be promoted, impacts to patch isolation, patch size, and edges, would continue. The vegetation

management activities may produce temporary perforations of habitat that would last from a few years to a few decades until regeneration stands meets identified habitat needs. In developed recreation sites such as campgrounds, fragmentation would result in a number of long-term changes to the landscape, including vegetation type conversions.

Effects on fragmentation and perforation from transportation/utility corridors

The development of transportation/utility corridors is expected to be similar in all alternatives. These linear developments are narrow bands of activities that generally are managed to maintain early seral vegetation. The corridors may slightly affect movement of some animals but no species have been identified for which these types of activities create total barriers to movement. They may make some species more vulnerable to predation as they move from one side of the corridor to the other.

Effects on fragmentation and perforation from mineral exploration and extraction (leasable)

Impacts would result from the construction and maintenance of roads and well pads during exploration, development, and extraction. This development would perforate habitats for more species during the development phase of activities. This development would result in smaller patch sizes and more edge in the developed areas, which may perforate some habitats for less mobile species. These areas are expected to be restricted in size.

The potential effects from a single exploration well would not vary by alternative. The acres available for leasing do vary by alternative: Alternatives D, E and F offer the least number of acres available, followed in order of increasing availability by the Preferred, the No Action, A, B, and C.

Effects on fragmentation and perforation from mineral exploration and extraction (locatable)

Development of access roads and ground-disturbing mineral exploration may affect some forest stands. The potential of intensive development of locatable minerals is considered to be low in all alternatives. The greatest number of acres of mineral withdrawal occurs in Alternative F, followed in declining amounts by E, D, the Preferred, No Action, B, and A.

Effects from recreation management on fragmentation and perforation

The construction and reconstruction of trails to meet recreation goals may affect some species. The least impact would be associated with Alternative F, which has the fewest miles of new trail construction and reconstruction, followed in order of increasing impacts by the No Action Alternative, Alternatives E and A, the Preferred Alternative, and Alternatives D, B and C, which all have over 20 miles of new trail construction or reconstruction per year. Alternative C may have the most effect with nearly 28 miles of trail construction per year. There is little or no information available regarding differences in impacts in fragmentation between motorized and nonmotorized trail use. Generally, wildlife species are able to move through areas with trails with little problem. The Chugach has not

identified the species for which trails would be considered a significant fragmented effect.

Effects on fragmentation and perforation from timber management

The fragmentation and perforation effects from timber management in forested ecosystems are discussed in more depth in the vegetation section of this chapter. Timber management and the associated facilities may perforate habitats. These effects may have positive impacts to species favoring early seral conditions and negative impacts to species favoring late-successional forests. These effects are short term and habitats would change as the managed stands age and progress through natural succession. Most species should be able to negotiate around or through the actual cutting units to suitable adjacent habitats; therefore these impacts would be perforation rather than fragmentation. The structural stages changes associated with even-aged timber management results have the most potential to perforate habitats.

The Preferred Alternative and Alternatives C, D, E, and F focus on uneven-aged management where less than 500 acres of timber could be harvested annually. Alternative B and the No Action Alternative would harvest approximately 1,000 acres of timber per year. The maximum effects would come under Alternative A, where 1,530 acres would be harvested.

Effects on fragmentation and perforation from access management

The construction and reconstruction of roads and trails to meet travel management goals would result in impacts to a variety of species. Two aspects of these activities would have the potential to affect wildlife species. First, the actual construction of the road would result in direct habitat loss for certain species. Second would be the indirect impacts associated with the human use of roads and trails after they are built. These impacts often are more significant in the long term. Restricting or prohibiting motorized use on roads can often greatly reduce the effects of the road to most wildlife species. The total miles of open roads and trails are the best measure of the effects of travel management on fragmentation/perforation. Roads may positively affect some animals (except for slow-moving individuals), but the majority of species show some level of aversion to roads opened for authorized use. No species on the Chugach has been identified for which roads would serve as a total movement barrier, but many species seek habitats away from actively used roads.

Total miles of available system roads is expected to increase in Alternatives A and B, and decrease from the existing situation in the Preferred Alternative and Alternatives C, D, E, and F in declining order.

Effects on fragmentation and perforation from fire management

Fire has always been a natural part on the Kenai Peninsula portion of the Chugach landscape. The use of prescribed fire to treat fuels or enhance wildlife habitats would result in early seral vegetation, usually in a mosaic of vegetation designed to resemble natural patterns. Some animals may find these treatment areas to be perforated. But due to the relatively small size of treatment areas and the resultant mosaic pattern, they normally would be able to move through or

around the burned areas to suitable adjacent areas. These treatments would not serve as fragmentation barriers to any identified species in all alternatives.

There is a total of 400 acres per year of this treatment in all alternatives (not including wildlife burns).

Composition

General

Whenever land management changes the extent and duration of a disturbance beyond the natural limits of the evolved disturbance regime, ecosystem composition, structure, and function can be adversely affected. Suppressed disturbances can lead to communities dominated by a few superior competitors, while extreme disturbance can lead to communities where only a few tolerant species can survive (Noss and Cooperrider 1994).

Disturbance is common in boreal forests such as that found on the Kenai Peninsula. In fact, these forests have been referred to as a “disturbance forest” because of the overall nature of fire (Rowe 1961). Fires and insect epidemics are both major disturbance processes. Spruce beetles have killed white spruce across much of its range on the Chugach.

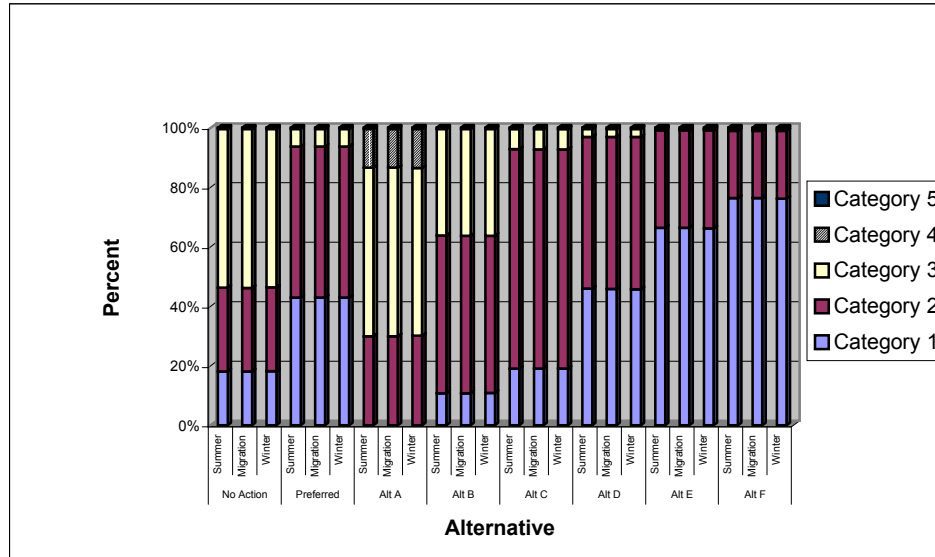
The composition of the Forest and the associated wildlife communities in the boreal forest is dependent upon the variation in the landscape due to these disturbances and others (Agee 1999). Both disturbance processes may cause significant variation in the seral conditions present depending on the intensity and scale of the disturbances. There is significant evidence of large stand replacement fires on the Kenai Peninsula over the past 200 years. If fire is suppressed on the Kenai, biodiversity associated with the early seral needleleaf and broadleaf forests would decline and there would be an increase in late seral forest communities. Maintaining a fire-dependent ecosystem through application of a vegetation management or prescribed fire management scheme would help maintain the composition of habitat patches and seral conditions within the ERV.



Direct and Indirect effects

The affect of each alternative on the species richness of the forest was determined by defining how the categories of land management area prescriptions might address species richness over three seasons - summer, fall migration, and winter. Figure 3-10 portrays the distribution of species richness by management area prescriptions for the three seasons.

Figure 3-10: Comparison of species richness for summer, migration, and winter by alternative.



All alternatives would provide habitat to maintain at least 30 percent of the species richness in Category 1 or 2 management area prescriptions. Alternative A provides the least amount of Category 1 and 2 prescriptions, followed by the No Action Alternative, Alternative B, Alternative C, the Preferred Alternative, and Alternatives D, F and E with the greatest amounts of Category 1 prescriptions.

Abundance and Ecological Diversity. Abundance of Forest land cover classes and habitats of special interest communities and ecosystems refers to the total acreage of Forest that meets structural, or functional criteria, based on ecological conditions. Ecological diversity is also indicated by the distribution of communities on the landscape, and the interrelationships among the variety of geographic, climatic, elevational, topographic, and soil distributions.

Four possible outcomes that characterize different levels of abundance and ecological diversity of the land cover classes and habitats of special interest communities and ecosystems were used to represent the possible outcomes from each alternative.

Outcome #1. Land cover classes and habitats of special interest are equal to or greater than the long-term (100-year) average, and are well-distributed across environmental gradients, geographic areas, and vegetation community types.

Outcome #2. Land cover classes and habitats of special interest are somewhat less than the long-term average in some geographic areas and forest types. There is representation of all major forest types but with under representation in some types (may be within range of variability).

Outcome #3. Land cover classes and habitats of special interest are below the long-term average in most forest types. Examples of a few old-growth types are eliminated.

Outcome #4. Land cover classes and habitats of special interest are well below the long-term average in all geographic areas. Examples of several old-growth types eliminated in some geographic areas.

At the Forest level, all alternatives appear to maintain land cover classes and habitats of special interest in amounts necessary to maintain viable populations well-distributed. As Duffy and others (1999) point out using coarse filter surrogates may not adequately represent the location and range of biologically important sites. For example, although a large portion of an ecoregion or the Forest may be within some type of protected status that does not ensure the range of biodiversity in that Forest is also in a protected status. The distribution of many of the species may reflect ecological conditions operating at a smaller scale. To account for biological structure or composition occurring at a smaller scale, analysis was also done to consider if any of the geographic areas would not be represented with at least 12 percent in Category 1 and 2 prescriptions.

Only the No Action Alternative does not have at least 12 percent in Category 1 or 2 prescriptions on the Kenai Peninsula. All alternatives but the No Action provide at least 12 percent of the land cover classes and habitats of special interest in amounts above 12 percent. The No Action Alternative meets this level for Prince William Sound and the Copper River Delta, but does not have at least 12 percent in Category 1 or 2 prescriptions on the Kenai Peninsula. In the No Action Alternative, most of the Kenai Peninsula would be managed for fish, wildlife, and recreation priorities.

The relative change in vegetation structure due to management activities proposed for action was also considered for short-term and long-term effects. The change in total structural stages resulting from all activities would be relatively small in all alternatives, ranging from a maximum of 3.9 percent in the first decade for Alternative A to 1.6 percent in Alternatives E and F.

Listed in order of total structural change, the alternatives are: A, No Action, B, C, Preferred, D, E and F. Changes in structural stages from timber harvest would be limited to four watershed associations. One each on the Kenai Peninsula and in Prince William Sound and two on the Copper River Delta. Under favorable market conditions, the amount of old growth remaining in those watershed associations would exceed 85 percent in the No Action Alternative and Alternative B. McKinley Lake (54 percent), Martin River NW (75 percent), and Snow River (84 percent) would be below the 85 percent level after the first decade.

The ability to use management activities such as timber harvest, forest restoration, and prescribed fire and other mechanical treatments to create mosaics of early seral conditions to meet other objectives was also considered. All alternatives provide some opportunity to maintain early seral conditions with prescribed fire and to use active management.

Overall, it appears that Outcome #1 (land cover classes and habitats of special interest) are equal to or greater than the long-term (100-year) average, and are well-distributed across environmental gradients, geographic areas, and vegetation community types) best describes all alternatives.

Process and Function. Processes refer to the ecological changes or actions that lead to the development and maintenance of forest and non-forest ecosystems at all spatial and temporal scales. Examples include: (1) tree establishment, maturation, and death, (2) gap formation and filling, (3) understory development, (4) small- and large- scale disturbances such as landslides and wind, (5) decomposition, (6) nitrogen fixation, (7) canopy interception of energy and matter, and (8) energy and matter transfers between the forest and atmosphere.

Functions, as used in this analysis, refer to ecological values of the various ecosystems or their components that maintain or contribute to the maintenance of populations of species that used these ecosystems, and that contribute to the diversity and productivity of other ecosystems. Examples of ecosystem functions include: (1) habitat for organisms, (2) climatic buffering, (3) soil development, and (4) the maintenance of soil productivity through inputs of coarse woody debris, nitrogen fixation, spread of biotic and abiotic disturbance through landscapes, and nutrient cycles (production, storage, utilization, and decomposition).

The scale of proposed management activities across the Forest is very small; between 1.6 and 3.9 percent of the forest structural stages would change due to management activities such as timber harvest, prescribed fire, soil and water habitat restoration, developed recreation construction and the associated road construction.

Connectivity across the landscape has been fragmented and perforated from past actions. Proposed activities under all alternatives would provide for strong connections within the islands in Prince William Sound and on the Copper River Delta. Connectivity of forested ecosystems on the Kenai Peninsula is moderate due to moderate distances between old-growth areas. Timber harvest areas would contain high levels of old-growth elements and riparian areas. Stand structure and dynamics and landscape/structure/dynamics/age structures would occur across all geographic areas and within all watershed associations.

The ecological diversity of the forest communities and ecosystems is well-distributed across environmental gradients, geographic areas, and vegetative communities in all alternatives. Overall, the effects are that the full range of disturbance processes would continue across the Forest under all alternatives.

Aquatic Ecosystems and Essential Fish Habitat

Introduction

Fish are a major component of biodiversity of the Chugach National Forest. The annual spawning migrations of anadromous fish (fish that spend part of their life in the ocean such as salmon) are necessary for the function of many plant and animal communities. Anadromous fish are a keystone species, with dozens of birds and mammals consuming salmon or salmon eggs. Animals such as black and brown bear and bald eagles are dependent on spawning salmon, or their carcasses for over-winter survival.

Fish and the other aquatic resources on the Forest provide major subsistence, commercial, sport fisheries, and traditional and cultural values. Abundant rainfall, streams with glacial origins, and watersheds with high stream densities provide an unusual number and diversity of freshwater fish habitats. These abundant aquatic systems of the Chugach provide spawning and rearing habitats for many of fish produced in Southcentral Alaska and Prince William Sound. Maintenance of this habitat, and associated high quality water, is a focal point of public, state, and federal natural resource agencies, as well as user groups, Native organizations and individuals.

Legal and Administrative Framework

There are numerous Acts that have set the basis for the protection and management of fish habitat. These acts have been revised and updated relative to the times. The four most dominant Acts are described below.

- **The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA)** - This act requires an assessment of the present and potential productivity of the land and provides guidelines for land management plans which will insure that timber harvested from national forest lands only where soil, slope, or other watershed conditions will not be irreversibly damaged.
- **The National Forest Management Act of 1976 (NFMA)** – Included in the Act is direction to include coordination of wildlife and fish when providing for multiple use and sustained yield. NFMA also requires the Forest Plan to provide for diversity of plant and animal communities. Implementing regulations specifically identify riparian areas for special management attention and identify an area at least 100 feet from the stream bank or areas dominated by riparian vegetation as a significant area. The regulations also give direction concerning maintaining viable populations of existing and desired non-native vertebrate species and using management indicator species (MIS) to estimate the effects of planning alternatives on fish and wildlife populations.
- **The Alaska National Interest Lands Conservation Act of 1980 (ANILCA)** - ANILCA permits the fishery research, management,

enhancement, and rehabilitation within national forest Wilderness and Wilderness Study Areas. It gives direction to cooperatively plan fish enhancement activities with the State of Alaska and nonprofit aquaculture corporations.

- The **Magnuson Stevens Fishery Conservation and Management Act of 1996 (as amended)** requires that a Federal Agency shall consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect any essential fish habitat.
- The **Alaska Forest Resources and Practices Act of 1990 (AFRPA)** provides management direction for both state and federal lands and call for the establishment riparian habitat buffers along all Stream Class (anadromous fish) and Stream Class II (resident fish) streams.

Key Indicators

- Percentage of coho and pink salmon habitat by prescription category
- Acres and miles of improved habitat
- Amount of disturbance from timber harvest

Resource Protection Measures

Forestwide standards and guidelines, the USDA Forest Service Soil and Water Conservation Handbook of Best Management Practices (1996a), and minerals leasing stipulations provide direction for minimizing adverse impacts to water and attendant fisheries resources. The majority of the fish habitat standards and guidelines are defined by soil and water concerns, and are designed to protect and maintain such elements as stream channels, stream banks, riparian vegetation, and water quality. Management indicator species (MIS) will be monitored during project implementation to indicate the effects of management activities on fish and fish habitat.

These protection/mitigation measures may be found in the draft Aquatic Ecosystem Management Handbook (USDA Forest Service 1999b). The basis for protection is the identification of the riparian area. The riparian area is the area identified during project planning that directly affects the form and function of the aquatic ecosystem, stream processes, and the quality and quantity of fish habitat. Riparian areas include the land adjacent to the water body, and the upslope areas that have a direct effect on aquatic habitat (also see Water/Riparian/Wetlands section in this chapter).

The protection measures apply to all alternatives. Once an alternative has been selected and implementation starts, monitoring will be initiated to determine if the appropriate protection measures have been implemented and if the measures

are adequate. Changes in either the method of implementation or the protection measure will occur if either does not adequately protect the fisheries resource.

Habitat Capability

Fish Management Indicator Species

National Forest Management Act regulations direct the use of MIS in forest planning to help display the effects of forest management (36 CFR 219(9)(1)). MIS are species whose population changes are believed to indicate the effects of land management activities. Through the use of MIS, the total number of species that occur within a planning area is reduced to a manageable set of species that represents, collectively, the complex of habitats, species, and associated management concerns.

For the Forest Plan revision, pink salmon, coho salmon and Dolly Varden char were selected as MIS. Pink salmon were selected to represent anadromous fish which are limited in their freshwater life-period by spawning gravel quality and quantity; coho salmon to represent anadromous fish that are generally limited in their freshwater life-period by stream and lake rearing area; Dolly Varden char because of their widespread distribution in freshwater habitats. Cutthroat trout were selected as a species of special interest because coastal cutthroat trout in Prince William Sound exist in small isolated populations at the westernmost extension of their range.

Affected Environment

Forestwide

The Forest includes approximately 4,600 miles of known fish streams and over 110,000 acres of fish lakes ranging from a few acres to the approximately 14,000-acre Kenai Lake. Anadromous fish habitat includes 1,800 miles of documented anadromous streams and 48,100 acres of anadromous fish lakes. Almost 2,000 miles of smaller stream channels are suspected to contain anadromous populations, but are not currently inventoried. Another 2,800 miles of stream provide resident fish habitat, with about 3,000 miles of smaller uninventoried streams. There are over 60,000 acres of resident fish lakes. Most of the Forest's streams and rivers empty into bays or estuaries which are important during some life stages of anadromous fish species as well as for many saltwater fish species. Table 3-24 shows the documented miles of anadromous fish habitat by species and landscape area.

Table 3-24: Documented miles of fish habitat by species and area.

Species	Copper River	Kenai Peninsula	Prince William Sound	Forest Total
Chum	84	109	231	424
Coho	616	315	197	1127
Cutthroat	191	0	34	225
Dolly Varden	429	121	30	579
King	174	160	9	344
Pink	150	161	590	901
Sockeye	557	242	81	881

Eulachon, *Thaleichthys pacificus*, are pelagic schooling smelts, that live in marine environments offshore of the Chugach National Forest, and also spawn in fresh water within Forest lands. There are two major spawning populations on the Forest. These are found on the Twentymile River on the Kenai Peninsula area and on the Copper River Delta.

Grayling, though not native to the Chugach National Forest, are currently found within the Kenai Peninsula and the Copper River. These populations are the result of an earlier introduction of grayling, and have become self-sustaining populations. Presently they occupy the Crescent Lake watershed on the Kenai and 18 Mile ponds on the Copper River Delta.

Channel Inventory and Stream Habitat Types by Landscape Area

All known perennial streams have been mapped and identified using the Alaska Region Stream Channel Type System. For a description of each channel type, see *A Channel Type Users Guide for the Tongass National Forest* (USDA Forest Service 1992a). These channel types have been found to fairly consistently fit the streams on the Chugach National Forest. Individual channel types have fairly consistent physical and biological characteristics (Marion et al. 1987; Edginton et al. 1987; and Murphy et al. 1987). The channel types provide a system to estimate the amount and quality of fish habitat and can be used to predict their physical response and sensitivity to different management activities. Channel types have been categorized into distinctly different groups, called “stream process groups.” Process groups are used for assigning the Fish Habitat and Riparian standards and guidelines. These are set out under the draft Alaska Region’s Aquatic Ecosystem Management Handbook (USDA Forest Service 1999b). Table 3-25 displays the amount of the channel type process groups found throughout the Forest by landscape area.

Table 3-25: Miles of stream by process group and area.

Process Group	Copper River	Kenai Peninsula	Prince William Sound	Forest Total
Alluvial Fan	54	66	98	218
Estuarine	277	6	127	410
Flood Plain	251	165	169	584
Glacial Outwash	1,105	287	411	1,802
High Gradient Contained	566	1,211	2,223	4,000
Low Gradient Contained	0	30	15	45
Moderate Gradient Contained	79	97	351	527
Moderate Grad/Mixed Control	46	202	272	520
Palustrine	611	85	71	766
Total	2,990	2,147	3,736	8,873

The Copper River landscape area is characterized by large amounts of Glacial Outwash streams, Palustrine and Floodplain type streams. Mountain glacier melt water is the source of runoff to the Glacial Outwash streams. Consequently these streams carry extremely high sediment loads and turbid water. Riparian areas are wide and may extend for several thousand feet of either side of the channel. These channels are accessible to anadromous fish in their lower reaches. Typically they provide migration routes to salmon spawning in clear water tributaries. The fine sediment in the spawning beds normally limits spawning gravel quality. Sockeye tend to select gravels where upwelling groundwater is present. Rearing habitat is generally limited to slough and side channel pools due to turbid water conditions.

The Palustrine streams are low gradient streams associated with bogs, marshes, wetlands, and lakes. These channels are shallowly incised, have fair flow containment, and flood flows usually overtop the stream banks and flow onto the adjacent landform, lessening downstream flooding and serving as a buffer during the major storms. Productivity of the channel is moderately tied to the riparian/terrestrial interaction. The Palustrine streams have high production capability for coho salmon. Spawning gravels are not abundant, but are usually more limited in "overwinter" habitat due to lack of large complex pools that provide quality winter habitat. The better rearing habitat, winter habitat is tied to undercut banks and large woody debris accumulations, as well as larger ponds and lake outlets.

High gradient contained stream channels dominate the Kenai Peninsula watersheds. These channels generally have low fish habitat capability. The productive areas for fish habitat on the Kenai Peninsula are dominated by Floodplain and Moderate Gradient with mixed control of stream banks channel types found in the valley bottoms. These floodplain and channels have two-way interaction between the stream channel and floodplain area through bank erosion, channel migration and overflow, leaf fall, and blow down/tree fall. These channels receive moderate to high spawning use by all anadromous species. Coho salmon and Dolly Varden char use the available rearing areas of these channels extensively. Much of the better rearing habitat, particularly the coho salmon rearing habitat, is associated with large woody debris accumulations,

beaver dams, and off channel sloughs. Sockeye production is associated with large lake systems found within the Kenai watershed, but frequently use the flood plain and mixed control channels for spawning.

Watersheds in Prince William Sound are dominated by high gradient channels. Productive fish habitat is also dominated by the relatively small percentage of floodplain and mixed control habitat types. Unlike the Kenai landscape area, Estuarine Channel Type streams, though small in total miles, are extremely important within the Prince William Sound. Sockeye salmon producing watersheds are limited in extent within Prince William Sound. Coghill Lake and Eshamy Lake are primary producers of sockeye in Prince William Sound. These channels are always accessible to anadromous salmon, and provide the primary area for pink and chum spawning.

Fish Stream Class Inventory.

Channel typed streams have also been categorized by stream class, a classification primarily associated with fish use. Class I streams are anadromous and high value resident fish streams, Class II streams are other resident fish streams, and Class III streams are managed for water quality and where appropriate, downstream aquatic resources. Stream classes describe stream values, such as whether anadromous or resident fish inhabit a particular stream. Fish Habitat standards and guidelines are based in part on the stream class. Table 3-26 shows the miles of stream by channel type.

Table 3-26: Miles of class I, II, and III streams.¹

Stream class	Copper River	Kenai Peninsula	Prince William Sound	Forest Total
Class I	1,991	521	765	3,277
Class II	156	554	725	1,435
Class III	566	1211	2,223	4,000
Total	2,713	2,286	3,713	8,712

¹ Does not equal totals in other tables due to some stream segments without stream class designation.

Current Management of Fish Habitat

Current fisheries habitat conditions on the Forest are near levels of natural productivity. Management actions that could be detrimental to fish habitat have occurred on limited amounts of stream habitat. Approximately 16 miles (less than one percent) of anadromous fish streams have had commercial logging within associated riparian habitat. Another 73 miles (less than one percent) of non-anadromous streams have had logging within associated riparian habitats. Water withdrawal has also affected a very small percentage of stream habitats, less than 5 miles. In addition, mining has impacted a small, though currently unknown, percentage of stream habitats within the Forest. Currently, there are watershed analyses being undertaken to address the most pressing of these problems.

Of concern, primarily on the Kenai Peninsula, is the long-term effect of the spruce bark beetle infestation. Specifically, the long-term changes to fisheries

habitat resources associated with loss of large spruce trees found within riparian zones are of concern. Frequently, spruce stands are a major component of riparian vegetation, particularly along streams with developed floodplains. These are typically some of the most productive fish streams. Currently, there are 65 miles of high value, Class I streams that have been impacted by the spruce bark beetle. These are concentrated on several high fisheries value streams, particularly the Russian River, East Fork Sixmile Creek, Juneau Creek, Resurrection Creek, and Quartz Creek.

Habitat Enhancement

Commercial fish harvest in the waters of Southcentral Alaska can fluctuate widely from year to year. For example, wild salmon harvest in Prince William Sound averaged approximately 8 million fish for the past 30 years. Since 1971, harvest of coho salmon and sockeye salmon attributable to Forest streams from the Copper River/Bering River are estimated to average 80,000 sockeye and 500,000 coho. Chugach National Forest streams on the Kenai Peninsula are estimated to produce an estimated annual harvest of 375,000 sockeye, 1,400 king, and 32,000 coho salmon. Current fish hatchery production in Prince William Sound averages 32 million fish, with 90 percent being pink salmon. Minor hatchery augmentation occurs on the Chugach National Forest portion of the Kenai Peninsula. Sport harvest within these same waters has also risen dramatically, increasing more than 100 percent in the waters within and adjacent to the Chugach.

Numerous fish habitat enhancement projects, and a variety of hatchery and other aquaculture projects, have been developed on the Forest. Two groups coordinate fish enhancement and development activities in Southcentral Alaska: the Prince William Sound-Copper River Regional Planning Team and the Cook Inlet Regional Planning Team. The Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division facilitates the activities of the coordinating groups. Between 1984 and 1997, 60 anadromous fish and 27 inland fish enhancement projects were coordinated by the Forest Service.

Environmental Consequences

The environmental consequences discussion that follows provides an assessment of management action impacts on essential fish habitat as directed in the consultation agreement between the Forest Service and the National Marine Fisheries Service.

General Effects

Fish and aquatic habitat can be affected by a variety of management activities including road construction, timber harvest, fire management, intensive recreation use, water depletion and diversion, and mineral development. These management activities may cause some adverse changes in fish and aquatic habitats that may affect the water balance or alter sediment and nutrients inputs. Fundamental changes to a watershed can create structure and function changes

in streams. This, in turn, can result in the change in numbers, growth, and distribution of fish.

Management activities can change fish and aquatic habitat in several ways. First, loss of stream bank stability or watershed soil structure and stability can contribute to the increases in the amount of sediment being added to the aquatic systems. The addition of sediment to aquatic systems as a result of watershed disturbance and erosion eliminates aquatic insect habitat, reduces the permeability of spawning gravels, and degrades pools and rearing areas (Chamberlin et al. 1991). Stream bank erosion can also contribute to the loss of available habitat. These changes usually lead to reduced spawning success, decreased capacity to support rearing fish, slower growth, and increased predation.

Another significant factor is a decreased supply of large woody debris (Doloff 1983). This may result in long-term losses of fish habitat. Reduction in the amount of pools and the available hiding cover decreases the rearing habitat capability, particularly over wintering habitat, and decreases spawning success. The species diversity in the stream may be reduced and predation on fish increased. The less complex habitat also loses some of its ability to capture gravels and organic matter important to spawning and rearing fish. Also, the large woody debris provides a substrate for food production.

Combined Rearing Habitat Capability Group – Management Indicator Species (MIS) are used to evaluate the relative potential impact on stream rearing fish habitat. These include coho and pink salmon, cutthroat trout (resident and anadromous), rainbow trout, and Dolly Varden char (resident and anadromous). Typically these fish use streams or rivers for spawning and their fry, upon emergence, rear in the stream habitat for one or more years (resident cutthroat trout and Dolly Varden char depend on freshwater systems, including streams, throughout their life cycle). The relative risk to each of these species could be influenced by the proportion of their life cycle residing in the freshwater ecosystem. Since resident cutthroat trout and resident Dolly Varden char are dependent on freshwater ecosystems throughout their lives, they could be at greatest risk. Some species such as cutthroat and rainbow trout appear to have isolated populations, which may be more susceptible to local impacts. Coho salmon both spawn and rear (for one or more years) in freshwater. The survival of these fish depends on the deep, quiet pools created by large woody debris, undercut banks, backwater sloughs and channels, and large bottom substrates (Heifetz et al. 1986).

Forest streams with uncontained stream channels, i.e., floodplain, palustrine, moderate gradient mixed control, estuarine, and alluvial process groups, are the most productive and sensitive channel types on the Forest. The balance between flow regime and sediments of the valley bottom controls alluvial channel form. Management activities that impact streamside vegetation can weaken channel banks and remove large woody debris sources. Removal of the streamside vegetation increases sediment supply and can cause the channels to become wider and shallower, with fewer pools and more riffles. This creates

conditions that support less coho juveniles. Bedrock controlled reaches, whose channel form is dictated by the bedrock control of valley wall or stream bank, are more resilient and stable to changes in stream flow and sediment supply. These bedrock reaches are contained within the Low Gradient Contained, Moderate Gradient Contained, and High Gradient Process Groups. See Table 3-25, Miles of Streams by Process Group and Area, for distribution of these habitats on the Forest.

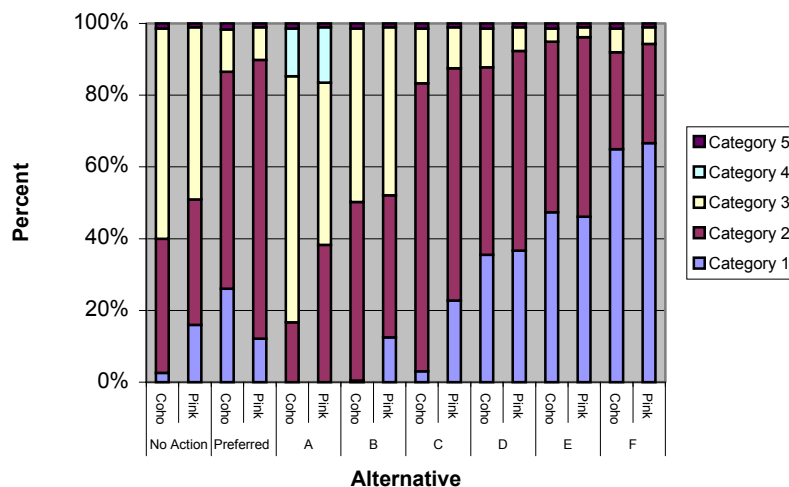
Coho salmon are highly dependent on quality rearing habitat for their health and growth in the freshwater environment. Coho juveniles spend 1 to 2 years in freshwater before emigrating to saltwater as smolts. The quality and quantity of year-round rearing habitat are the basis of the production potential of streams. For coho salmon, the number of smolts produced by the stream system is directly related to the winter survival of the juveniles. The number of adult coho available to the subsistence, sport, and commercial fishery as well as the brood stock escapement is directly related to the number of smolts.

Combined Stream Spawning Capability Group - A combined group of fish includes coho, pink and chum salmon, rainbow trout, cutthroat trout (resident and anadromous) and Dolly Varden char (resident and anadromous). Typically these fish use streams or rivers for spawning, and their fry, upon emergence, rear in the stream habitat for one or more years (resident cutthroat trout and Dolly Varden char depend on freshwater systems, including streams, throughout their life-cycle); or, as with chum and pink salmon, migrate to salt or brackish waters to rear. Pink and chum salmon rear in saltwater after emergence from freshwater incubating habitats. Since pink and chum salmon have relatively similar habitat requirements, and are highly tied to the abundance and quality of spawning habitat, pink salmon is used to represent the group since they are more widely distributed on the Forest than chum salmon. Substrate composition, water quality and quantity, water depth and velocity are important components for pink salmon spawning and successful incubation of eggs to fry. Spawning generally occurs in riffles, with preferred sites occurring at the pool-riffle interface. A constant supply of clean well-oxygenated water is critical to the survival of eggs in the gravel. Unlike coho, pink salmon do not spend 1 to 2 years rearing in freshwater. Not long after emergence from the gravel, pink fry start their out-migration to saltwater. Management actions that could potentially affect pink habitat capability are those that would alter migration of juveniles or adults, or affect the spawning and incubation habitat by increasing the amount of fine sediments in the gravel or by destabilizing the gravel.

Generally, as total miles of roads and acres of potential timber harvests increases and recreation sites and mineral sites are developed, the potential of altering the structure and function of critical habitat is increased. Therefore, the possibility of impacts to species abundance increases with increased miles of road constructed and acres harvested, or intensive recreation management within riparian habitats. For some species, such as small isolated populations, the potential impact may have greater significance than for others.

A qualitative method to determine this potential risk to spawning and rearing habitat is to look at the percentage of the anadromous fish habitat that is within the five prescription categories (Figure 3-11). As the prescription category increases the potential level of management intensity increases. Implementation of Category 1 and 2 prescriptions, with their low level of ground disturbing activities, such as roads, trails, timber harvest units, and campgrounds, has a low probability of altering the structure and function of fish habitat. Those alternatives that have a higher percentage of Category 1 and 2 prescriptions have less risk for potential negative effects to aquatic habitat. Only coho and pink salmon percentages have been graphed, as the distribution of cutthroat and rainbow trout, and Dolly Varden char are not fully represented on the Forest Streams GIS layer. Also coho salmon and pink salmon serve as representatives for the combined rearing and spawning groups.

Figure 3-11: Percentage of coho and pink salmon habitat by prescription category.



In order of decreasing risk (greatest risk to least risk) to both the physical characteristics of stream channels and the species considered, the alternatives can be ranked in this order: Alternative A, the No Action Alternative, Alternatives B and C, the Preferred Alternative, and Alternatives D, E and F.

Salmonid Viability

It is recognized that regardless of the level of fish habitat protection, some level of risk remains that fish habitat could be impacted by some management activities. The conservation of the aquatic community and salmonids within watersheds of the Chugach National Forest is based on a strategy that addresses both individual species as well as entire watershed assemblages (Marcot et al. 1994). The species approach is important for management indicator species (MIS), species of special interest (SSI), or sensitive or rare species. The species-specific approaches, such as MIS, have not always been successful in protecting biodiversity (Angermeier and Schlosser 1995). Grossman

and others (1995) contended that maintenance of fisheries is best accomplished at the landscape scale. Bisson and others (1997) argues that managing aquatic habitats with emphasis on natural disturbances would promote conservation of aquatic organisms contained within those watersheds. But the conservation of aquatic ecosystems or communities may be more important than individual species protection, and may be a more viable strategy for keeping species populations at fishable numbers well-distributed.

Species focused approaches should be complemented by efforts to protect distinctive landscapes or watersheds. Grossman and others (1997) and Bisson and others (1997) state that though stream reaches can be defined as discrete habitat units, the connectedness of the habitats is essential for long-term salmonid viability. For freshwater aquatic ecosystems the watershed concept should work. It is assumed that Category 1 and 2 prescriptions protect the natural processes at a landscape scale and continue the continuity of the separate habitat units. The exception to this is within watershed associations on the Kenai Peninsula that have had extensive placer mining operations. These include the Resurrection Creek, Juneau Creek and Cooper Creek watersheds. Here the Chugach National Forest watersheds are still dominated by native species; the natural processes are still functioning within the expected range of variation within these undisturbed watersheds.

To further evaluate level of risk, the percentage of watershed associations where natural processes dominate are identified. Management areas with prescription Category 1 and 2 were considered to fully protect watershed and habitat values. Watershed associations were considered large enough to maintain the core values needed to maintain habitat characteristic. The watershed associations were examined to determine whether any were predominately (95 percent) Category 1 or 2 prescriptions.

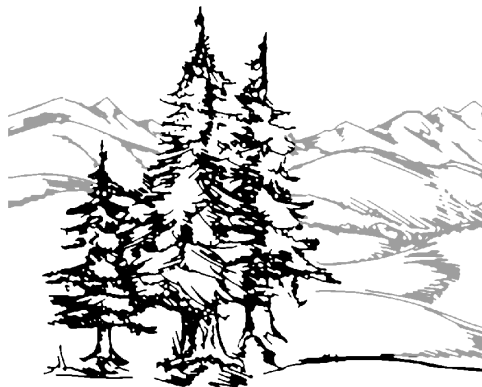
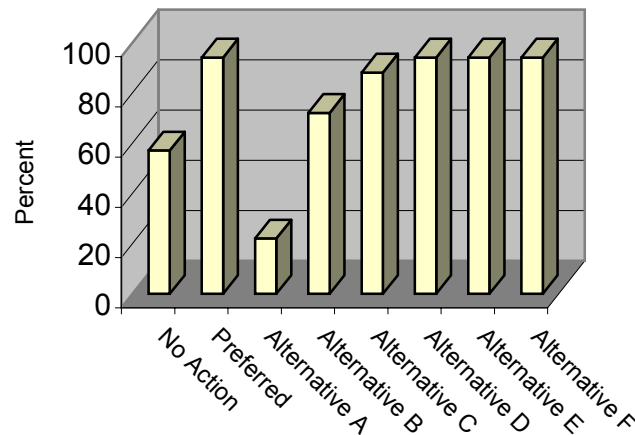


Figure 3-12 shows by alternative the percentage of watershed associations that are 95 percent or more within Category 1 or 2 prescriptions.

Figure 3-12: Percentage of watershed associations within Category 1 and 2 prescriptions.



The maintenance of watersheds within primitive and semi-primitive prescriptions, if fully implemented, does however address the NFMA regulation regarding habitat for maintaining viable, well-distributed populations in the Forest. Alternatives D, E, F, and the Preferred Alternative maintain nearly all (94 percent) of all watersheds within prescriptions that protect watershed an fish habitat values. Only Alternative A has more than half of the watersheds within developmental oriented prescriptions.

This “coarse filter” approach keeps ecosystem components within the expected range of variability; other stressors for populations have been identified. These are the potential viability risks to pink salmon from permitting fish hatcheries, or risks to cutthroat trout due to increases in angling pressure within Prince William Sound.

Pink Salmon

Supplemental production of hatchery produced pink, sockeye, chum, coho, and king salmon occurs within Prince William Sound. The Prince William Sound Aquaculture Corporation operates five hatcheries, and the Valdez Development Association operates another. The issue of the enhancement of the hatchery stocks of salmon for the Forest Service at the Main Bay and Cannery Creek Hatcheries, the two hatcheries with Chugach National Forest special use permits, has on wild, or naturally occurring stock is addressed in this section. Primarily, the Forest Service issue is with sockeye salmon at Main Bay, and wild pink salmon throughout Prince William Sound.

Currently, there is much uncertainty about the effect of hatchery production on the productivity and long-term production of biological surplus of wild salmon stocks within Prince William Sound. The additional sockeye salmon smolts and pink salmon fry produced at these hatcheries, potentially increase resource competition and genetic interactions between wild and hatchery stocks. Sharp and others (1994) reported high rates of straying of hatchery produced pink salmon into streams within Prince William Sound. Without mitigation, hatchery produced salmon could potentially dilute locally adapted gene pools of naturally produced salmon through straying and result in shifts of traits that directly relate to the fitness of these stocks (Eggars et al. 1991). Changes in size at maturity, age at maturity, migration, or spawning times, or egg emergence times could occur. Such changes could have a bearing on the long-term survival of those stocks, although the short-term effects would probably not be detectable.

There has been mixed success in meeting wild pink stock escapement goals (Kron 1998). ADF&G manages for wild stock escapement, consequently when escapement numbers in index streams (streams that are monitored for spawners) are low, the interception fishery is curtailed and commercial fisheries are restricted to terminal harvest areas, which lie outside the wild-stock migration corridors. The escapement goals for the pink salmon in Prince William Sound have generally been reached, though there is growing evidence that the large scale production hatchery stocks appears to be replacing pink salmon wild stock production, rather than augmenting the total production. Eggars and others in 1991 and Tarbox and Bendock in 1996 both suggested that hatchery fish were responsible for the decline in wild pink salmon production. Interaction of wild and hatchery stocks may also occur during adult return and commercial fishing activities. There may be wild stocks of several different species that would be intercepted during commercial fishing efforts directed at hatchery stocks. Recently Hilborn and Eggars (2000) have argued that hatchery stocks of pink salmon are impacting the wild pink salmon returns through over harvesting wild salmon stocks in a mixed stock fishery, and wild and hatchery pinks are sharing ocean habitat. There is also uncertainty about the effect of hatchery stocks flooding the wild stock gene pool. Potential loss of genetic fitness might result in lower reproductive juvenile and adult survival rates and loss of long-term viability.

The viability of pink salmon within Prince William Sound probably is not in question, though genetic integrity of stocks and long-term productivity of wild stocks within certain portions of Prince William Sound or individual streams may be in question. The escapement goals for streams within Prince William Sound have been met every year since the inception of the hatchery program (Kron 1998). Escapement throughout individual streams has been somewhat variable, with inadequate escapements in some commercial fishing districts in Prince William Sound in some years. Uniformity of escapement is another issue. While overall yearly escapements may have been reached, escapement may have been inadequate within certain commercial Sub-Districts. The ability of wild systems to produce biological surplus for subsistence, sport, or commercial uses may be compromised by continued high hatchery production and mixed stock commercial fisheries.

Though escapement goals have been met in most years, it appears that viability of wild stocks of salmon is generally maintained, though the contribution of wild salmon carcasses to the freshwater and riparian ecosystem would be reduced significantly. Wilfli and others (1998, 1999) have described the influence of salmon carcasses on the stream productivity and concluded that they provide key nutrients for high salmon production, as well as providing ecosystem nutrition for riparian associated plants and animals. The loss of this potential nutrient source on ecosystem function needs research. Run strengths of Coghill Lake sockeye salmon have also been strong in recent years, following sockeye fry supplementation and lake fertilization programs, so viability issues are also probably not present.

These issues of wild stock impacts need to be addressed by the Prince William Sound Advisory Council and ADF&G. Studies could include mark and recovery programs, genetic baseline determinations, genetic marking, fishery interception determination and others needed to effectively validate the existing hatchery programs and to provide direction to the program to assure protection of wild stocks.

Cutthroat Trout

Coastal cutthroat trout (*Oncorhynchus clarki clarki*) are found through Prince William Sound and the Copper River Delta. They are found as anadromous (sea run), potomodromous (river run), Lacustrine (lake run), and resident populations (Trotter 1989). Cutthroat stocks known to exist within Prince William Sound are small and geographically isolated. Williams and others (1998) have found that resident and anadromous populations in small genetically isolated populations within Prince William Sound. This is consistent with the hypothesis that low barriers are barriers to upstream cutthroat migration, and as such several of the populations may exist in unknown levels of reproductive isolation and genetic differentiation. Above barriers, the small fish are genetically isolated from anadromous forms, but how much downstream migration is unknown (Johnston 1981). Heggens and others (1991) found that coastal cutthroat trout showed little migration within small streams, and larger fish were least likely to move.

Populations of coastal cutthroat have been surveyed within some of western Prince William Sound; other areas throughout the Sound may contain populations of cutthroat trout (Barto et al. 1984, Pelliser et al. 1985a, Pelliser et al. 1985b, McCarron and Hoffman 1993). Populations were impacted by the *Exxon Valdez* oil spill. Growth of anadromous populations was significantly reduced (Hapler et al. 1993). The recovery level of growth rates of cutthroat trout is unknown at present. Arguments have been made that cutthroat trout populations within western Prince William Sound might be in jeopardy due to the relative isolation, small population size, ease of capture by anglers, and projected increase in angler numbers due to the Whittier road, and the potential increase in numbers of anglers employing outfitters and guides. Currently, no guides or outfitters with Chugach National Forest special use permits are targeting freshwater fishing opportunities (Hennig personal communication).

Projected angling impacts are currently quite modest with western Prince William Sound. Cutthroat harvest numbers since 1988 for all of the Prince William Sound area has ranged from 122 in 1995 to 1,511 in 1989, averaging 705 fish (Howe et al. 1999). In 1998 the estimated harvest was 737, while total numbers caught was 4,101. This indicates that a high level of catch and release occurs for cutthroat. In 1998 the number of fish harvested within western Prince William Sound was estimated to be 109, assuming all other streams and lakes not listed by Howe and others (1999) are within this area. While this is a low number, because of the unknown location of many of the populations, the small size of many of these populations, and their genetic isolation, future research and monitoring would be useful in assuring viability of the populations.

Direct and Indirect Effects on Fisheries and Aquatic Habitat

Effects from Fish Habitat Management

Fish habitat management is focused on salmon and trout habitat protection, restoration, and enhancement. Primary emphasis of the program is protection of existing habitat value. Restoration of damaged habitat resulting from human caused or natural events is also an important component of the program. The final program component is enhancement of habitat values. While enhancement projects may not result in large increases in anadromous and inland fish, compared to current natural and hatchery production, increasing access and value of habitat can benefit fisheries in several ways. Enhancement is focused on localized populations that can benefit subsistence, sport, or directed commercial fisheries. The habitat is also used to buffer the effect of commercial fisheries on wild stocks.

The amount of fish habitat manipulation proposed during the planning period varies by alternative and would be spread across the Forest. Table 3-27a shows the proposed fish habitat enhancement program. Improvements are allowed within all prescription categories, though implementation of projects is constrained by difficult access and program implementation requirements within Recommended Wilderness Management Areas. These restrictions require significantly more resources to accomplish an equal numbers of acres and miles. Alternatives E and F have fewer miles and acres because natural processes would dominate fish management.

Table 3-27a: Miles and acres of fish habitat management by alternative (annually).

	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Anadromous Habitat								
Stream Improvements (miles)	82	82	82	82	82	82	82	82
Lake Improvements (acres)	1,722	1,722	1,722	1,722	1,722	1,722	1,722	414
Riparian treatments (miles)	222	222	222	222	222	124	93	93
Inland Fish Habitat								
Stream Improvements (miles)	0	0	0	0	0	0	0	0
Lake Improvements (acres)	391	391	391	391	391	391	258	191
Riparian treatments (miles)	25	25	25	25	25	14	11	11

Effects from Road Construction

Road construction and use may be the greatest potential sediment source over both the short term and long term. Roads constructed in riparian areas can constrict floodplains and channels resulting in changes to channel morphology and fish habitat (Furniss et al. 1991). Road construction on steep mountain and hillslope landforms commonly found on the Kenai Peninsula increases the likelihood of landslides, which transport large quantities of sediment and woody debris. The rate of failure would be dependent on storm events. Upon reaching streams, the material can block or cause channel shifts, alter existing habitat structures, fill in pool rearing habitats, and increase fine sediment in spawning gravel. These changes would likely decrease the habitat capability to produce fish.

Approximately two percent of the watershed associations on the Chugach are currently roaded. However, none of the 95 watershed associations are considered to be roaded in relation to roads causing fundamental watershed process changes. The percentage of roads would increase under all alternatives, though the No Action Alternative and Alternatives A and B are the only alternatives that propose to build more than a few miles of new road per decade.

Cederholm and others (1982) found that in the Clearwater River within western Washington, the percentage of fines sediments in spawning habitat increased above natural levels when roads occupied more than 2.5 percent of the basin area. King and Tennyson (1984) found that hydrologic behaviors of small watersheds were altered when roads occupied more than 4 percent of the watershed.

The existing and new roads associated with the No Action Alternative and Alternatives A and B fall below these threshold levels. The only network of roads that were considered for analysis were the four watershed associations considered for timber entry under high market values. The maximum increase, given a scenario where all harvest activities and road-building activities were

contained within a specific watershed, is the 30,400-acre McKinley Lake watershed. McKinley Lake was chosen because it has the highest concentration of potential roads within a watershed association. Alternative A, under the high timber market conditions, has the highest potential road density. The road density would be 0.03 percent, two orders of magnitude below the threshold.

Roads can also be viewed as causing risk to fish movement, primarily due to culverts being used on moderate to high gradient streams. At highest risk are stream-rearing fish, particularly cutthroat trout and Dolly Varden char, which occupy the smaller headwater streams during some parts of their lives. In general, resident species are not as sedentary as previously thought (Armstrong and Elliott 1972, Trotter 1989). High quality spawning habitat may be some distance from high quality rearing or over wintering habitat of lakes, ponds or pools of large rivers. Juveniles of other stream-rearing fish such as coho salmon are often highly mobile during their freshwater stage, moving seasonally between stream reaches, so they are also at risk. Survival often is dependent on this seasonal movement (Bustard and Narver 1975). Restrictions in upstream movement could have impact to overall habitat capability. A recent report on the Tongass National Forest (Flanders and Cariello 2000) found serious problems with culverts blocking fish movement. Preliminary results, based on criteria that approximate juvenile fish passage at mean flood condition, suggest that up to 85 percent of the culverts located on salmon streams and up to 66 percent of the culverts located on resident trout streams were not considered to be adequate for fish passage. The relative risk to fish passage would be related directly to the miles of road constructed and number of stream crossings.

Given these criteria, Alternatives A and B would have nearly the same risk as they would have nearly the same road mileage (220 miles) at the end of first decade. The No Action Alternative would have about 170 miles of road. In descending order of risk from road effects are the Preferred Alternative and Alternatives C, D, E, and F, all with significantly less road, between 120 and 130 miles.

Effects from Timber Management - Timber harvest activities increase risk to fish resources. The risks of these effects are proportionate to the intensity of the management treatments, the juxtaposition to the riparian areas, and the sensitivity of the harvest area to increased erosion. Of particular concern is the protection of riparian areas including flood plains, areas of riparian vegetation, and certain wetlands associated with riparian systems. Commercial timber harvest is not permitted in riparian areas. However, non-commercial harvest and other tree removal is permitted in some riparian areas. Also of concern is the amount of protection afforded steeper channels (often not fish-bearing) in the headwaters areas. It is important to maintain the natural function of these steeper channels, including the V-notches. Forested leave strips are considered to be an important measure to insure protection of headwater areas (Murphy and Koski 1987). However, there is risk of unanticipated stream habitat effects such as accelerated numbers of landslides over background levels, blow down of riparian buffers, and the cumulative effects of many small and individually

insignificant actions affecting fish habitat capability. Harvest activities may increase erosion and siltation of streams and reduce large woody debris input to streams as a result of riparian vegetation disturbance. There is potential for reduction of key habitat components, for juvenile coho with regard to disturbance of off channel habitat and low gradient tributaries. Management influence on off-channel habitat usually consists of bank disturbance, small logging debris loading of these habitats, and sedimentation or disturbance from upstream activities that are not mapped before timber harvest. Mitigating these potential effects by avoiding or minimizing timber harvest activities in riparian areas is felt to be the key means of minimizing impacts to fisheries habitat from logging (Chamberlin 1982, Dolloff 1987, Murphy et al. 1986, Johnson et al. 1986).

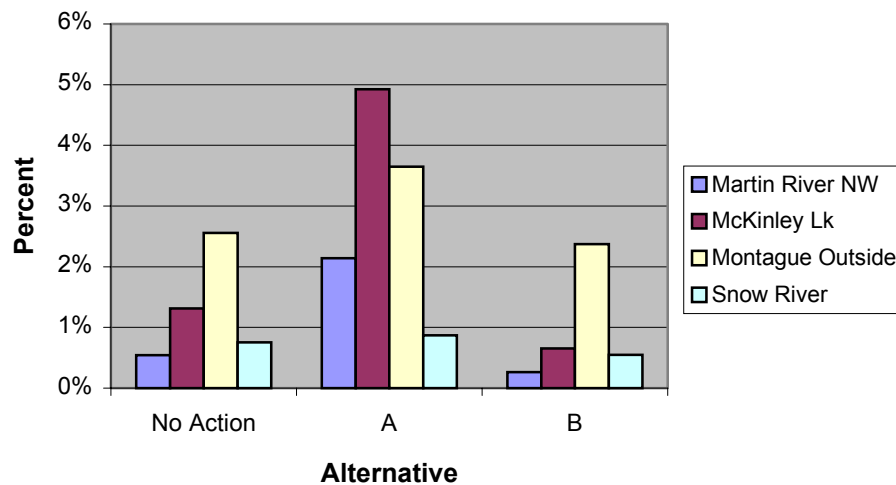
Timber harvest within riparian areas may lead to increases in primary productivity and secondary productivity. Increases in summer water temperatures created by reduced canopy closure from timber harvest or other vegetation removal projects may also increase algae growth. Other possible outcomes to increased sunlight/increased algae growth are increased water temperature and a decreased solubility of oxygen in the water. This has been documented to result in increased adult fish respiration causing fish mortality in heavily logged watersheds. These can lead to increases in summer salmonid carrying capacity. For stream-rearing fish, both resident and anadromous, the amount of overwinter habitat is considered critical.

Intensive timber harvest activities have potential to impair hydrologic function in watersheds. Concerns for impaired hydrologic function include peak flows, sediment transport and summer low flows. The peak flow and sediment transport issues are closely interrelated. Studies in the Pacific Northwest have shown a range of stream peak and low flow responses to various levels of watershed harvest. An Alaska study speculated that measurable decreases in flow occurred when 30 percent of a watershed was harvested. Tongass land management planners recommended a threshold level, following a recommendation by a team of hydrologists (Cumulative watershed effects, 1996) of no more than 20 percent of the acres in a watershed will be in an age class of 30 years or less (USDA Forest Service 1996b). The 1995 Alaska Region Anadromous Fish Habitat Assessment Report to Congress indicates that declines in salmon capability may occur after timber harvest of more than 25 percent of the watershed (USDA Forest Service 1995a).

The implementation of the Alaska Region's Best Management Practices and Riparian standards and guidelines outlined in the Tongass Land Management Plan were judged to be inadequate for completely protecting productivity of aquatic habitat (USDA Forest Service 1999b). As stated above, heavily logged watersheds, those with more than 25 percent of their acreage harvested, would have a loss of fish habitat productivity. In contrast to these highly developed watersheds, alternatives considered in the Chugach Forest Plan revision effort, have much lower levels of potential development. Figure 3-13 displays the percentage of the four watershed associations that timber harvest would possibly occupy within the next decade. Harvest occurs only in the No Action Alternative

and Alternatives A and B. None of the alternatives proposes harvest of more than 5 percent of the watershed associations. Given the low intensity of harvest, no fundamental changes in watershed processes affecting fish habitat would be likely.

Figure 3-13: Percentage of watershed associations harvested under high market conditions.



Source: Chugach National Forest GIS corporate database Stream and Watershed layers.

The No Action Alternative and Alternatives A, and B increase the likelihood that fish dependent on the freshwaters of the Forest could be negatively affected by timber management activities. Although there are specific measures in each alternative designed to reduce the likelihood of significant degradation of fish habitat, there remains a risk to fish associated with management activities planned under each alternative with commercial timber harvest. Several studies have shown that buffer strips are adequate in protecting site-specific fish habitat (Murphy et al. 1986, Johnson et al. 1986, Barton et al. 1985). The potential of timber harvest to reduce coho and pink salmon habitat capability is mitigated by the protection of near stream resources by no harvest zones as prescribed in the draft Aquatic Ecosystem Management Handbook (USDA Forest Service 1999b), and by BMP effectiveness in protecting water quality in the upstream habitat areas. The impacts would be directly related to the effectiveness of the implementation of the standards and guidelines.

Effects from Fire Management

Fire can have both positive and negative effects on fish and their aquatic habitat. Fire can release important elements such as nitrogen and phosphorous into the aquatic systems. These increases are temporary and usually dissipate after re-vegetation occurs. There is speculation that such increases could increase the productivity of the streams during this period. Alaskan streams are relatively

sterile. Thus, productivity increases in plants and animals that provide food sources may lead to increases in numbers of fish.

Key physical components of a fully functioning aquatic ecosystem include complex habitats consisting of floodplains, banks, channel structure (i.e., pools and riffles), and subsurface waters. These are created and maintained by upslope disturbance processes, including fire, that supply nutrients, woody debris, and water. Large intense fires may lead to changes in these upslope processes. These wildland fires can have short-term detrimental effects, particularly to certain fragile soil and channel types, in the form of increased sedimentation, channel degradation, and changes in stream temperature regimes. Wildland fires would average about 15 acres each year under all alternatives.

Over time (500 years or more), streams within the Kenai watershed are clearly disturbance-dependent systems. To maintain aquatic viability throughout a large drainage basin, it is necessary to maintain features of the natural disturbance regime. Fire is a factor in the natural disturbance regime on Kenai forested watersheds.

Alternatives that propose the greatest use of prescribed fire to reduce fuels and manage vegetation would directly benefit aquatic habitat, while concurrently reducing the risk of large catastrophic wildfires that could, at least in the short term, damage aquatic systems. The No Action Alternative, the Preferred Alternative, and Alternatives A, B, and C propose approximately 27,000 acres of burning during the first decade on the Kenai Peninsula. Alternative D proposes about three quarters as much and Alternatives E and F propose about half as much. Table 3.27b shows the potential number of stream miles by stream class that would be within or adjacent to prescribed burns.

Table 3-27b: Potential stream miles affected by prescribed fire – decade 1.

Class	Alternative						
	No Action	Preferred	A	B	C	D	E
Class I	14.7	14.7	14.7	14.7	14.7	11.4	7.4
Class II	15.6	15.6	15.6	15.6	15.6	12.1	7.9
Class III	34.1	34.1	34.1	34.1	34.1	26.5	17.3
Total	64.4	64.4	64.4	64.4	64.4	50.0	32.6

Effects from Lands And Special Use Management

Dams and water diversions can have significant effects on aquatic and riparian habitat and fish migration by changing channel dimensions, altering aquatic and riparian habitat, and obstructing fish migration. The degree of these effects is currently unknown.

As permits are amended, renewed, or issued, the Forest will analyze environmental effects to determine if additional mitigation measures or new terms and conditions are required. Effects would be similar under all proposed

alternatives, since the compliance standards included in permit issuance would not vary by alternative.

Effects from Minerals Management

Mining and fossil fuels extraction can affect fish and aquatic habitat. Mining can be a significant source of bedload sediment or toxic heavy metals introduced into streams. Other risks include altered streamflows and channels, acid-mine drainage, toxic substance spills, and altered temperatures. Normally, water is needed in mining operations, and this depletion of streams or underground aquifers may also adversely affect fish habitat.

Both hard rock mining and oil and gas leasing operations proposed on National Forest System lands include a variety of resource protection stipulations and requirements. These operations are carefully monitored to ensure compliance with the terms of the mine operating plan or lease agreement. Even though these protection measures are required under all proposed alternatives, it is still reasonable to assume that those alternatives that open the most acreage to mining or oil and gas leasing potentially pose the greatest risk of adverse direct, indirect, or cumulative effects to fish and aquatic habitat.

In terms of risk assessment, the alternatives, from greatest to least risk, would be ranked as follows: Alternative A would open the most acres to mining, followed in order by, Alternative B, the No Action Alternative, Alternative C, the Preferred Alternative, and Alternatives D, E, and F (see Table 3-95).

Effects from Recreation Management

The relation between recreation and salmon aquatic habitat is complex. It represents a relation between habitat and the people. The indirect effect of overuse of streamside zones by recreational users is difficult to judge. The criteria to judge the potential effects of recreation of aquatic habitat are the amount and number of recreational visitor days and the degree of access. Sport fishing is a major recreational activity on the Forest, but a variety of other recreational uses, such as motorized vehicle use, boating, hiking and horseback riding, could damage riparian and aquatic habitats. Some of the activities are dependent on the aquatic environment and have potentially more impact on fish habitat. Fishing, particularly at areas where returning adult salmon congregate, may create localized impacts. Such sites are currently found on the Russian River and Quartz Creek and impacted sites are increasing as recreation use increases.

Recreational use can affect aquatic habitat in many ways. The most obvious ways on the Chugach National Forest is through the loss of streamside riparian vegetation and changes in the upland soils. Riparian zones are transitional areas that lie between the river channel and the upland. They provide important fish habitat and hydrologic functions by controlling floods and erosion. The riparian vegetation functions as a buffer and filter system between upland development and the river, maintaining water quality by absorbing nutrients, accumulating and stabilizing sediments and removing pollutants from upland development. These areas are also where a major part of the Forest sport

fishing and other recreational activities are concentrated. The trampling of soils by anglers, hikers or others using the riparian areas can result in soil compaction, reduction in organic matter and root exposure. User developed trails may also result in collection of surface water, with rutting and erosion. Loss of soils can lead to sediments entering salmon habitat, and result in a reduction in spawning and rearing habitat, negatively affecting spawning gravel quality, or filling in the pools, or loss of undercut banks (Furniss et al. 1991).

Riparian zones, floodplains, and alluvial landforms are probably the most sensitive areas to recreational developments and use. In their review Clark and Gibbons (1991) found that even light recreational use could impact riparian vegetation causing mortality of the over story, loss of tree vigor, root kill, and loss of ground cover. They also indicate that keeping roads and trails away from sensitive areas is important in controlling impacts. Baxter and others (1999) have suggested that alluvial, or floodplain sections of streams are the most critical and sensitive reaches of watersheds. Gunderson (1968) found that floodplain development altered the stream morphology and fish populations. On the Kenai Peninsula, the intensive use of the floodplain has resulted in a decline of chinook habitat capability. Liepetz (1994) evaluated the effects of development and recreational use on the rearing habitat capability on the Kenai River. He found, using juvenile chinook as an indicator, that 11 to 12 percent of the shoreline habitats had been impacted by bank trampling, loss of vegetation, and structure or facilities development. Griglak (2000) also found that, before extensive bank restoration activities starting in 1996, the lower Russian River experienced significant loss of stream bank stability due to recreational angler trampling. Comprehensive rehabilitation efforts on these areas have resulted in an improvement of habitat quality (Griglak 2000).

Access can also play a critical role in determining potential impacts on aquatic habitat by either hindering or facilitating recreational use of the streams and lakes. As previously described, roads may have a detrimental impact on salmon habitat (Furniss et al. 1991). Clark and Gibbons (1991) suggest that access management is critical to protecting the quality of fish habitat. In their review, Clark and Gibbons (1991) state that if roads and trails are kept some distance away from the stream channels, detrimental impacts to habitat may be kept at a minimum. The standards and guidelines for the Revised Forest Plan call for keeping roads and trails out of riparian areas, with incursions into riparian habitat only where necessary to cross from one side of the valley to another, or to direct recreational users to specific spots, such as viewing spots or angler access.

Recreational gold panning that is allowed under most prescriptions also has potential to impact spawning habitats. Some use of motorized suction dredges is allowed within all alternatives. Griffith and Andrews (1981) found that suction dredging stream gravels resulted in destruction of salmonid embryos and alevins within the affected spawning substrate. Roberts and White (1992) indicate that the eggs of alevins are most vulnerable during the second part of their incubation within stream gravels. Harvey and Lisle (1998) in their review of the potential impacts of suction dredging on fish habitat indicated that the impacts go beyond

the direct impacts to incubating salmon eggs. Dredging of stream banks can have long lasting effects on stream channel stability. Dredging within the riffle crests could destabilize spawning sites and reduce the number of aquatic invertebrates. Also, fine sediments are mobilized and may be cast over spawning substrates. Juvenile and adult salmonid are not affected, as they are sufficiently mobile to not be directly impacted.

In response to these potential effects, the standards and guidelines for recreational gold panning include timing restrictions to protect the eggs and alevins in the gravels. The size of dredge equipment is also regulated to limit the amount of gravel that can be processed. The dredging of banks within the active stream channel is prohibited. Motorized dredge equipment is not allowed within Category 1 and Category 2 nonmotorized prescriptions. The Forest is currently directing recreational gold mining into several areas on the Kenai Peninsula. Since not all of the potential impacts can be mitigated there is some potential for damage to salmon habitats. As shown in Table 3-27c, the number of anadromous stream miles open to recreational mining using suction dredge equipment within major placer gold producing areas is a good measure of the intensity of this potential impact.

Table 3-27c: Miles of anadromous streams open to motorized suction dredging.

	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Miles	105	37	117	107	42	29	24	27

Intensive recreational fishing sites are not expected to change much between alternatives, but the access to them does. Access decisions may have implications on how people use an area, and subsequently on how much streamside disturbance would occur. As the distance from access points increases, the use of salmon and trout streams decreases. The location of roads and trails near streams could have indirect impacts on aquatic habitat. Alternative B, with emphasis on more summer motorized recreation in the road corridor and in backcountry areas could put more motorized riders in high value fisheries habitat. Damage to streams from anglers trampling banks may be mitigated by restrictive angling regulations.

In their paper, Clark and Gibbons (1991) determined that light use, such as those associated with primitive or semi-primitive ROS classes, results in only minor impact. Still localized impacts can occur, particularly where camp sites, trails and other facilities are located within the riparian areas (Kuska 1977, Settergram 1997). Burns (1991) suggested that small or minor impacts could have cumulative effects on aquatic habitat and organisms.

Given these findings, those alternatives that emphasize primitive and semi-primitive recreation would have less risk of adversely affecting fish and aquatic habitat. Table 3-28 displays the Class I stream miles within each ROS class. The No Action and Preferred Alternatives, as well as Alternatives C, D, E, and F

have nearly all acres allocated to primitive and semi-primitive prescriptions (from 93 to 96 percent).

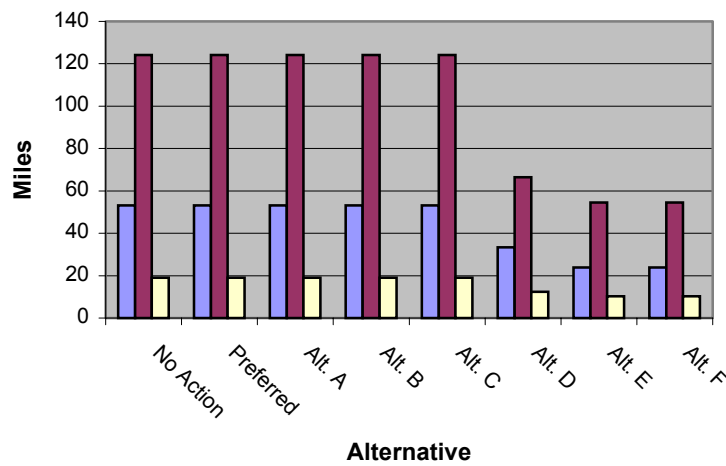
Table 3-28: Class I stream miles within each ROS class.

ROS Class	Alternative							
	No Action	Preferred	A	B	C	D	E	F
PI	2	77	2	2	143	315	319	348
PII	209	948	0	0	0	416	819	961
SPNM	1,074	1,351	58	1,251	1,791	1,448	1,131	992
SPM	1,156	79	1,552	486	449	251	182	158
RN	102	82	708	757	151	112	91	84
RM	4	5	187	51	11	4	4	4
R	6	10	45	6	8	6	6	6
Total	2,552	2,552	2,552	2,552	2,552	2,552	2,552	2,552
% ROS > SP	96%	96%	63%	68%	93%	95%	96%	96%

Effects from Vegetation Management

Vegetation, and particularly riparian vegetation, regulates the exchange of nutrients and organic material from upland forests and grasslands to streams. Vegetated riparian areas are particularly dynamic portions of the landscape. These areas are shaped by disturbances characteristic of upland ecosystems, such as fire and wind throw, as well as by disturbance processes unique to aquatic systems, such as channel erosion, peak flow, deposition by floods, and debris flows. Riparian areas are widely considered to be critical habitat for fish and aquatic insects. Maintaining the integrity of the vegetation is particularly important for these riparian-dependent species.

The loss of riparian vegetation to spruce bark beetle mortality within the riparian stream areas on the Kenai Peninsula is a management concern. First, after tree mortality, roots will eventually lose their soil holding capability, which could result in bank destabilization. Second, the long-term availability of large woody debris is decreased. Third, the introduction of leaves and needles into streams is disrupted, resulting in lower nutrient input. The riparian zones of the Russian River, Resurrection Creek, Quartz Creek, Bean Creek, and Dave's Creek have all been impacted by spruce bark beetle mortality. The difference in riparian restoration miles is based on the assumption that the Recommended Wilderness Management Area prescription does not allow for vegetation management activities. Figure 3-14 shows estimated miles of Class 1, 2 and 3 streams that would be restored by alternative.

Figure 3-14: Estimated miles of class I, II, and III restoration by alternative.

Effects from Wildlife Management

Generally, wildlife management projects would be expected to improve or have no effect on fish and aquatic insect habitat. Prescribed burning effects on fish habitat are similar to those described under the Fire Management section.

Cumulative Effects

Cumulative effects are similar in all alternatives. New management activities should not cause additional effects on freshwater fish habitat. The majority of the acres on the Forest would be managed through natural disturbance process. Changes to forested cover types, from all activities, ranges from 1.1 to 2.2 percent per decade. Productive habitat would continue to be well-distributed across the Forest. Riparian protection measures in these watersheds would likely mitigate many effects of management activities on the fisheries resource.

The inclusion of large blocks of Category 1 and 2 prescription areas in all alternatives increases the likelihood of maintaining rearing and spawning habitat capability. However, the risk of site-specific adverse effects increases in relation to the miles of roads constructed, acres of commercial timber harvested, and acres of intensive resource development. Risks include the adverse effects of sedimentation from unplanned events such as road failures or washouts of culverts and bridges; the failure of culverts and bridges to pass fish, even though they were designed to so; and, stream bank damage from recreation use. Alternatives A and B, the No Action Alternative, Alternative C, the Preferred Alternative, and Alternatives D, E and F rank in order of overall potential risk to fish.

Generally speaking, alternatives proposing construction or reconstruction of the most new roads would have the highest potential risk of creating adverse cumulative effects to the fisheries resource in watersheds currently rated

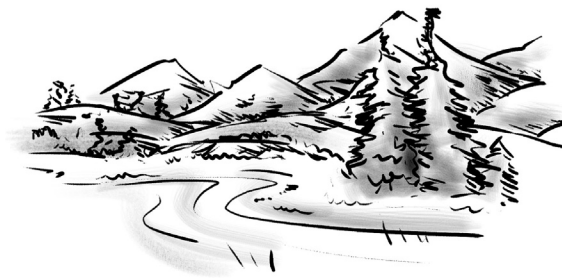
sensitive. This would include effects to both Forest and off-Forest streams. Alternative A proposes the most miles of road, followed by the No Action, B, the Preferred, C, D, E, and F.

There may be other contributing factors such as recreational or commercial over harvest, diseases, and hatchery practices that are responsible for fish population fluctuations. For fish species that are subject to exportation, state and federal regulatory mechanisms, such as population objectives, harvest objectives, sustainable yields and lengths and types of harvest seasons, play an important role in population ecology and species distribution across the Forest.

Essential Fish Habitat Summary

Many types of management actions have the potential to affect essential fish habitat. Various conservation measures will be implemented to minimize adverse effects on essential fish habitat, protecting and conserving habitat to support sustainable fisheries and their contributions to healthy ecosystems. These measures include management area prescriptions featuring low impact activities, at the forest plan level, and the implementation of the applicable Best Management Practices and standards and guidelines at the project level. Essential Fish Habitat assessments will be made during project planning and displayed in the project environmental document. Formal and/or informal consultation procedures (as directed by Section 305(b)(2) of the Magnuson-Stevens Fisheries Conservation Management Act, 1996) will be used with the National Marine Fisheries Service on all the projects that implement the Revised Forest Plan that potentially affect essential fish habitat.

We have concluded that the likelihood of Chugach National Forest resource management activities affecting the habitat needed for sustainable fisheries is low. Riparian and aquatic habitats are protected in all activities that have potential to affect fish habitat through the application of Regional and Forest aquatic ecosystem protection standards and Best Management Practices. Therefore, activities associated with implementation of the Preferred Alternative are expected to have minimal if any effect on essential fish habitat.



Fire Management

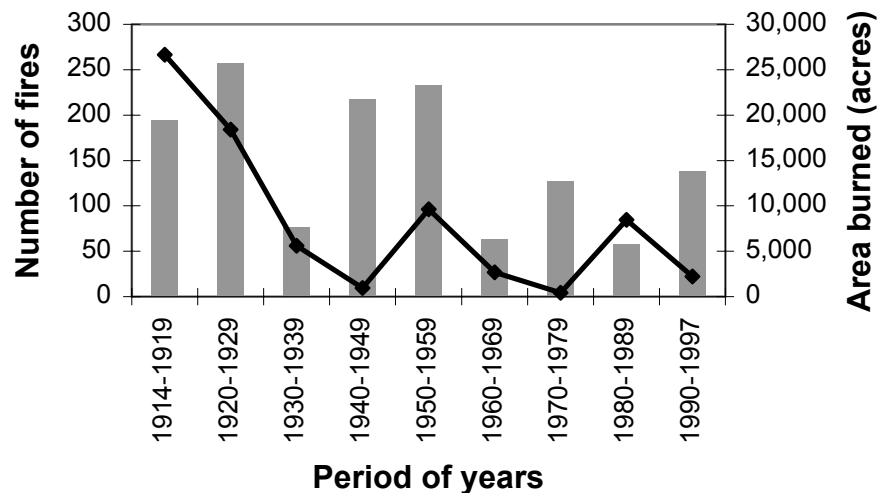
Introduction

Although the climate is generally not conducive to natural fire ignition (e.g., lightning strikes are rare), wildland fire has been an important influence on the Kenai Peninsula portion of the Chugach National Forest (Potkin 1997). The present landscape reflects human-caused fires that have occurred over the last 100 years or so, creating areas of early successional plant communities, which include large stands of broadleaved forests. These fires have generally increased the richness and patchiness of the vegetation at a landscape level.

The fire history of the area is described in three distinct periods – prehistoric (pre 1740), settlement (1741-1913), and post settlement (1914-1999). Fire has contributed to the landscape diversity most recently in the settlement and post settlement periods and periodically for the last several thousand years. Radiocarbon dates of five charcoal samples from soils at scattered locations in the Kenai Mountains ranged from 3,010 to 570 years before present with an average of 600 years between dates (Potkin 1997). Charcoal has been reported as present in most soil pits within the forested zone in the Kenai Mountains (Davidson personal communication). This anecdotal evidence suggests the occurrence of widespread, yet infrequent, fires in prehistoric times.

Prior to the settlement period of the late 1800s, the majority of the age structures of the coniferous forest surveyed were likely in late successional stages (Langille 1904) and conifers were likely dominant (Potkin 1997). If mature coniferous forests were dominant prior to the settlement period, the vegetation community diversity on the Kenai Peninsula was lower at that time and increased in the late 1800s and early 1900s, during a period of major fire occurrences. The fire history of the Kenai Peninsula includes infrequent, but large fires (Vanderlinden 1991). Figure 3-15a shows that about 1,400 fires have burned a combined 75,000 acres on the Kenai Peninsula portion of the Forest from 1914 to 1997 (Potkin 1997). Human-caused ignitions account for over 99 percent of these fires. The majority of fires have occurred in grassland vegetation types in the early fire season, from mid-April through June, with some activity in August and September.

Figure 3-15a: Fire history of National Forest lands on the Kenai Peninsula from 1914 to 1997 as indicated by the number of fires and acres burned by decade.



Source: Potkin 1997.

Today, fires generally fall into two categories: wildland fires and prescribed fires. A wildland fire is a fire resulting from an unplanned ignition. It requires an appropriate response to control its spread. A prescribed fire is a fire ignited by management actions to meet specific objectives, such as to reduce hazardous forest fuels or improve wildlife habitat.

Legal and Administrative Framework

- The **Organic Administration Act of 1897** authorizes the Secretary of Agriculture to make provisions for the protection of national forests against destruction by fire.
- The **Bankhead-Jones Tenant Act of 1937** authorizes and directs the Secretary of Agriculture to develop a program of land conservation and land utilization to protect public lands.
- The **Wilderness Act of 1964** authorizes the Secretary of Agriculture to take such measures as may be necessary in the control of fires within designated Wilderness while letting fire play a more natural role.
- The **National Forest Management Act of 1976 (NFMA)** directs the Secretary of Agriculture to specify guidelines for land management plans to ensure protection of forest resources.
- The **Clean Air Act of 1977** provides for the protection and enhancement of the nation's air resources.

- **Alaska Department of Environmental Conservation – 18 AAC 50 – Air Quality Control** - These are the air quality control regulations for the State of Alaska. The Chugach National Forest abides by the provisions of these regulations. The regulations set ambient air quality standards for the State of Alaska (for eight contaminants), as well as allowable maximum increases to air quality. Controlled burns greater than 40 acres require an ADEC permit.

Key Indicators

- Acres of fuels treated adjacent to communities, roads, trails, waterways, and other developed sites

Resource Protection Measures

Protection of life and property from the threat of wildland fire is one of the Forest's most critical missions. To accomplish this protection in the most cost effective manner, the State of Alaska has been divided into a series of four protection zones as outlined in the Alaska Wildland Fire Management Plan (1998).

Alaska is unique nationally by having developed one interagency fire plan across all land ownerships. The fire plan prioritizes areas according to fire protection levels based upon natural terrain, vegetative changes or values at risk, rather than changes in ownership. This recognizes the natural role of fire in the landscape, changing vegetative patterns that benefit wildlife and as a source of regeneration for some species such as black spruce. Interagency fire planning, involving all landowners and managers, defined four fire suppression protection levels. Prioritization of fire fighting forces can be based on the highest to lower protection levels.

The four protection levels are:

Critical Protection: Areas given this level of protection are those in which wildland fires would threaten human life, inhabited property and designated development. Wildfires that threaten a critical site have unquestioned priority over all other fires. The designation of a critical site or area is at the discretion of the land manager or owner and the manager/owner of surrounding lands.

Full Protection: Areas assigned this designation receive initial attack and aggressive suppression efforts on all fires until controlled. This option is designed to protect historical sites, uninhabited private property, high-value natural resources and other high value areas that do not involve protecting human life and inhabited property.

Modified Protection: The intent of this option is to reduce suppression costs and impacts of suppression action and to provide land managers/owners options within agency constraints and mandates. It allows for two responses to fire:

1. A relatively high level of protection during seasonal periods when fires usually burn with greater intensity, severity and frequency; and
2. A lower level of protection when the risks are large, damaging fires has diminished.

Limited Protection: This category is characterized by areas with low values at risk, where the impact of suppression may be more damaging or costly than the effect of fire. Suppression actions are taken only to the extent necessary to keep a fire within the management unit or to protect identified values. Site-specific areas that warrant protection may occur within limited protection areas. Appropriate suppression actions to protect these sites may be taken without compromising the intent of the limited protection areas.

An environmental analysis is used to determine the correct process to treat either active or natural fuel accumulations. If treatment by using a prescribed fire is desired, a burn plan is prepared to address the objectives of the environmental analysis. The burn plan addresses the correct method of applying fire while considering items such as air quality, protection of heritage resources, resource objectives, and public safety.

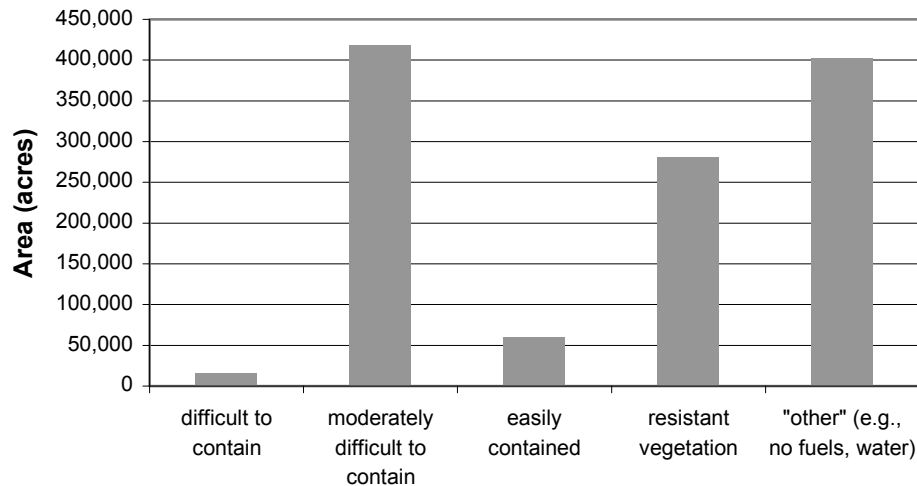
Affected Environment

Fuels

Eight fuel models are used to describe the forest fuels on the Kenai Peninsula (USDA Forest Service 1978, 1999a). The fuel models speak to the difficulty to contain fires. Current fuel loading data indicates increased chances for large stand replacement fires, with over 40,000 acres classified in the moderately difficult to contain fuel model class (Figure 3-15b). The major concern is that there are 1.3 million acres of dead trees on the Kenai Peninsula resulting from a spruce bark beetle outbreak since 1987. After a spruce bark beetle outbreak, grass and other fine vegetation generally increases (Holsten et al. 1994). Fire spreads rapidly through this vegetation type. As the spruce trees break or blow down over the next 5 to 20 years, large woody debris begins to accumulate on the forest floor. Monitoring in Resurrection Creek indicates a change from 0.32 tons per acre of 3-inch material to 23.16 tons per acre following the beetle infestation (USDA Forest Service 1995b). This wood is the largest component of the fuels complex. Heavy fuels are more difficult to ignite, but once lighted they burn at higher intensities and for longer duration. The combination of fine, flashy fuels and abundant large woody debris creates a hazardous fuels situation. The

high probability of human-caused ignitions (see Figure 3-15a) and the fact that over 32,000 acres of spruce bark beetle-infested stands with 70 percent or greater spruce mortality are within one mile of an existing roads and trails suggest a risk of large-scale fire occurrences on the Forest (DeLapp et al. 2000).

Figure 3-15b: Area by fuels model class on the Kenai Peninsula portion of the Chugach National Forest.



Source: Chugach National Forest GIS corporate database.

Wildland Fire

The Chugach National Forest is generally in a low-frequency/high intensity fire regime. From 1914 to 1999 approximately 1,420 fires burned a total of 75,000 acres within the Forest Boundary (Figure 3-15a). This is an average of about 16 fires each year. The average size of the fires was about 50 acres. About 75 percent of the fires have been less than a ¼ acre. Only two fires have been greater than 1,000 acres. Over 99 percent of all the acres burned were on the Kenai Peninsula. Humans caused over 99 percent of the fires. In the last 25 years, campfires account for over 50 percent of all wildland fires on the Forest. During the last decade, there have been 145 fires on the Forest. They have burned an average of 15 acres per year.

Prescribed Fire

Prescribed fire is used to meet management objectives, such as removing hazard trees, reducing hazardous fuels, reducing slash from timber harvest, improving wildlife habitat, and improving biological diversity. For a prescribed fire, a plan will be written and approved and NEPA requirements met before the burn is initiated. Currently, the Forest has a hazardous fuel-burning target of about 200 acres per year. Prescribed fire acreage will need to be increased over

the next 5 – 10 years in order to accomplish hazardous fuel reduction objectives. The location and timing of any prescribed fire will be decided on a site-specific basis after an analysis that includes fire hazard, fire risk, resource values and appropriate management area prescriptions applied to the land in the preferred alternative.

Environmental Consequences

General Effects

Fire hazards are greatest in older timber stands where an accumulation of ground fuels has occurred. The percentage of forestlands in mature condition is projected to increase under all alternatives.

In addition to fire hazard, the risk of ignition must be considered. The majority of ignitions are associated with humans and their activities (camping, hunting, etc.). There is no specific pattern to lightning ignitions. The risk of human-caused fires varies among the alternatives. As the level of human activity (primarily associated with transportation routes) increases, so does the risk of a human-caused fire. The No Action Alternative and Alternatives A and B have the greatest risk. The Preferred Alternative and Alternatives C, D, E, and F have the least risk.

Values are key in a description of the Forest fuel/fire situation. Urban interface zones, regenerated stands, unique habitats, domestic watersheds, and highway (visual) corridors are a few examples of high or moderate resource values. Other areas would have low or moderate resource values. The wildland fire management strategy or strategies are established for each management area in the Alaska Wildland Fire Management Plan (1998).

Direct and Indirect Effects

Wildland fire initial attack suppression efforts do not vary by alternative. Protection of life and property has the highest priority. Table 3-29 shows the fuel treatment program for the Forest, by alternative. Most all of this work would be accomplished by burning.

Table 3-29: Fuels reduction program.

	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Fuels reduction (acres/year)	400	400	400	400	400	400	400	400

Based on the analysis in the “Kenai Peninsula Spruce Bark Beetle Management Strategies & Five-Year Action Schedule”, all alternatives, including the Preferred, would treat 400 acres of vegetation per year with prescribed fire to reduce fuel buildups (USDA Forest Service 1999a). This in turn could lessen the intensity and rate of spread of a wildland fire.

The Kenai Peninsula is the area of primary concern on the Chugach because of the proximity of people and communities to hazardous fuels. A full range of fuels treatment activities are allowed or conditionally allowed on all lands on the Kenai Peninsula. This includes prescribed fire, mechanical timber stand thinning and tractor piling. The following prescriptions are applied to areas where hazardous fuels may be treated on the Kenai Peninsula: Backcountry (211); Backcountry Motorized (212); Scenic River (231); Brown Bear Core Area (242); Fish and Wildlife Conservation Area (244); Fish, Wildlife and Recreation (312); Forest Restoration (314); Recreational River (331); Developed Recreation / Reduced Noise (341); Resource Development (411); and, Developed Recreation Complexes (441). Some prescriptions prohibit road construction, reconstruction, and scheduled commercial timber harvest. However, mechanical methods of fuels treatment are allowed or conditionally allowed on all lands on the Kenai Peninsula.

Effects from Timber Harvest

Timber harvest activities generally reduce the natural fuel loadings. As the forest ages and moves into late successional stages, fuel loading increases. Timber harvest moves the forest into earlier seral stages, generally reducing the fuel loading. Timber harvest activities that create large canopy openings can also reduce the potential for fires that move through the crowns of trees, independent of surface fuels. Only the No Action Alternative and Alternatives A and B would have scheduled commercial timber harvest. Harvest under all other alternative would be limited to firewood and hazard tree removal.

Slash or activity fuels would be created through timber harvest. The timber purchaser would be required to follow State of Alaska fire regulations and would be prepared to suppress any fires within the contract area. The timber purchaser would be required to treat logging slash to reduce the threat of a high intensity wildland fire. This would greatly reduce the buildup of slash and the risk of fire. Timber harvest contract provisions also require timber purchasers to conduct their operation using fire precautionary measures. Personal use timber extraction usually leaves the slash scattered on the forest floor. This could increase the fire hazard. General statements about fuel levels in stands receiving timber harvest treatment versus fuel levels in untreated stands cannot be made. The situation depends greatly on the type of timber harvest treatment and the amount of slash disposal prescribed for the harvest area.

Effects from Recreation

Recreation use of the Forest is expected to increase under all alternatives. With an increase in the number of people using the Forest, the risk of human-caused wildland fires increases. Management of vegetation near communities, public concentration areas and transportation routes would help reduce the threat of fire to life and property.

Cumulative Effects

Vegetation changes on the 1.3 million acre Kenai Peninsula due to the spruce bark beetle infestation would have an impact on wildland fire suppression efforts

over time. Observations from recent fires on the Kenai Peninsula have shown an increase in crown fires. During the first three years after attack, beetle infested areas will become a higher fire threat when the needles turn red. After the needles drop off, the areas become a much lower threat than under a live tree situation. Several years after the needles drop, the areas will once again have an increased level of threat related to the invasion of blue-joint reedgrass (*Calamagrostis canadensis* (Michx.) Beau). The threat is not from a long duration ground fire/crown fire, but comes from a very fast spreading ground fire. After approximately 15 years the threat would be from the fast moving grass type fire and very limited access because the dead trees would be falling down.

Generally, a very large wildland fire on the Kenai Peninsula could occur under prolonged low humidity with little or no nighttime humidity recovery and increased winds coupled with a continuous fuels. However, weather conditions are variable and large fires are possible in these stands with fewer extremes in weather conditions. Large fires in proximity to human activities pose a threat to life and property. The vegetative mix where a fire could occur would dictate the level of resistance to suppression efforts.

The majority of wildland fires on the Chugach National Forest occur near communities, public concentration areas (e.g., campgrounds), along roads, trails, and waterways as a result of the human activities. When the fuel source is located in key areas (communities, public concentration areas, roads, trails, and waterways) and humans are present the probability of a wildland fire increases. A fire protection analysis has been completed for the Kenai Peninsula, which considers an assessment of fuel conditions, values at risk and the potential for human presence. The rest of the Chugach will be covered by a protection analysis at a later date, because the weather conditions are somewhat more humid and the risk of a wildland fire is lower.

Vegetation treatments (tree removal, mechanical manipulation or prescribed fire) and keeping those fuel levels lower over time afford the best opportunities to reduce the potential hazards of human-caused wildland fire. As rural development occurs in areas bordering the Forest, emphasis will need to be placed on reducing hazard fuels adjacent to these developments.

The risk of human-caused fires would increase under all alternatives due to projected increases in Forest visitor use. The risk of fires from lightning would remain constant under all alternatives. In alternatives where people can go more places (roads and trails), there are more locations that would be placed at risk, as human activities are a primary ignition source. In alternatives with less motorized access to the Forest, the risk of wildland fire would decrease. Fire prevention and enforcement can reduce the threat of human caused fire. Alternatives that retain roadless lands by limiting access or by removing direct treatment techniques such as timber harvest and thinning would have incremental negative cumulative effects.

Insects and Diseases

Introduction

Insects, diseases, and related decay processes are an integral and natural part of forest ecosystems. These disturbances play an important role in shaping forest composition, structure, and development. They are fairly widespread over the Forest and act over long periods of time. During periods of epidemic levels, however, dramatic and rapid forest change can occur.

Insect and disease-caused stresses influence species composition, diversity, density, nutrient cycling, and plant succession (Zasada et al. 1977). There is a large body of work describing the spruce bark beetle outbreak on the Kenai Peninsula, with aerial survey data dating from 1957 to today. Monitoring plots have been in place for over 20 year (Werner and Holsten 1983). Surveys in 1996 estimated that over 1,125,000 acres of forested land in Alaska were infested with spruce beetle and that on the Kenai Peninsula alone over 840,000 acres of spruce mortality has occurred since 1989 (Holsten and Burnside 1997).

Insects and disease, along with wildland fire, have been viewed as having negative influences on the Forest. This will still be the case where management objectives conflict with insect and disease outbreaks. However, where management objectives accept the impacts from these outbreaks as being part of the natural disturbance processes in the Forest, they are considered to be beneficial to the Forest's cycles of growth and decline and necessary to the maintenance of the Forest.

The long-range goal of insect and disease management is prevention and suppression through silvicultural treatment of susceptible stands. Control of insects and diseases on the Chugach Forest has been limited to the Kenai Peninsula in response to the on-going spruce beetle epidemic and has occurred primarily by salvage harvest of dead and dying trees and sanitation harvest to suppress damaging levels of insect and disease populations. However, these techniques are reactive, not proactive, and have done little to slow or suppress spruce bark beetle population levels. Pesticide treatment can reduce spruce beetles in high value areas such as campgrounds and administrative sites.

Since 1987, intensive spruce beetle suppression and salvage treatments have occurred in almost all the Forest's campgrounds on the Kenai Peninsula, some recreation trail corridors and trailheads, and in some stands with high levels of dispersed recreation or importance to wildlife along the Kenai River.

Stand management is now regarded as a way to develop stands that are much more resistant to attacks by insects and disease. In general, management activities that increase stand vigor will usually decrease stand susceptibility to insects or disease. The amount of forested land that may be susceptible to insects and disease may be related to the presence or absence of management.

Legal and Administrative Framework

- **36 CFR 219.16(a)(2)(iii)** – This regulation allows for the harvesting of stands of timber that have not reached CMAI (culmination of mean annual increment) which are in imminent danger from insect or disease attack.
- **36 CFR 219.27**– This section of the regulations sets the minimum specific management requirements to be met in accomplishing goals and objectives for the National Forest System. 36 CFR 219.27(a)(3) requires that all management prescriptions utilize principles of integrated pest management to prevent or reduce serious, long lasting hazards and damage from pest organisms, consistent with the relative resource values involved. 39 CFR 219.27(c) discusses the ASQ (allowable sale quantity) and states: “Nothing in this paragraph prohibits salvage or sanitation harvesting of timber stands which are substantially damaged by fire, windthrow, or other catastrophe, or which are in imminent danger of insect or disease attack and where such harvests are consistent with silvicultural and environmental standards.”

Key Indicators

- Acres infested with spruce beetles (Kenai Peninsula)
- Acres of management area prescriptions in which vegetation or timber management is emphasized
- Acres of proposed vegetation and timber management activity

Resource Protection Measures

Resource protection is accomplished through Forestwide and management area prescription standards and guidelines. Sanitation and salvage sales may be used to suppress insect and disease activity where necessary and allowed.

<h2>Affected Environment</h2>

While there are numerous insects and disease species on the Forest, only those pest species that are considered to be a management concern are discussed below.

Insects

White spruce (*Picea glauca* (Moench) Voss) and Sitka spruce (*Picea sitchensis* (Bong.) Carr.) are affected primarily by spruce beetle while western and mountain hemlock are affected primarily by black-headed budworm.

Spruce Bark Beetle – Spruce beetles are a permanent resident of spruce forests and are one of the most important disturbance agents in mature white spruce stands in Southcentral and Interior Alaska.

As in Southeast Alaska, outbreaks in the Southcentral Alaska coastal forests of Prince William Sound and Copper River Delta are generally smaller and of shorter duration than outbreaks in the forests of the Kenai Peninsula and Interior Alaska, which are larger and of longer duration.

The spruce beetle responds quickly to large-scale blowdown of spruce trees from wind, fire-scorched trees, spruce injured by flooding, or in residual (cull) logs left after land clearing or timber harvest. Large numbers of beetles can be produced in such breeding material, leading to potential outbreaks that spread into adjacent standing trees. Weather conditions appear to play a role in the expansion or contraction of beetle populations. Extensive, dense, stands of even-aged spruce trees are at greater risk of large-scale epidemics compared to more diverse forested areas containing a mixture of cover types and structural stages (between stands or within stands).

Spruce beetle populations in Prince William Sound and Copper River Delta are endemic in nature, while over the last two decades the spruce beetles have been at epidemic levels on the Kenai Peninsula and the rest of Southcentral Alaska killing several million acres of mature spruce forest.

The estimated acreage affected by the spruce beetle epidemic on the Kenai Peninsula portion of the Forest is displayed in Table 3-30.

Table 3-30: Estimated acreage impacts of spruce beetle on the Kenai Peninsula, Chugach National Forest.

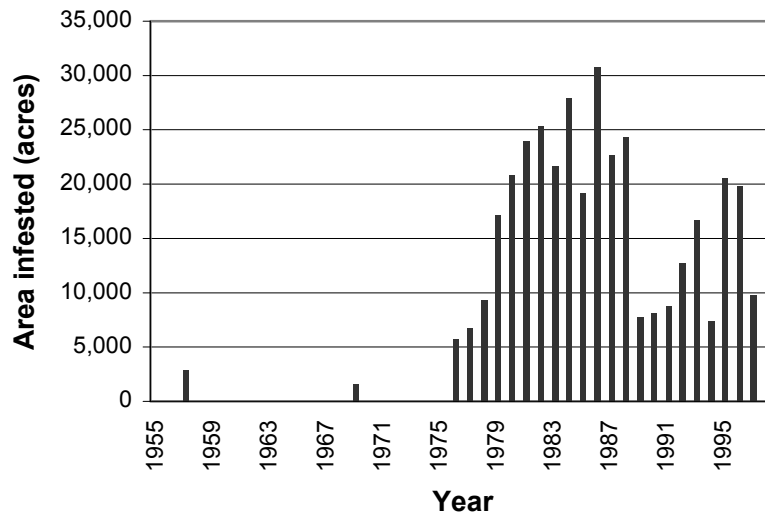
National Forest System land on the Kenai Peninsula	Total Acres	Percent Of Total Acres	Percent of Total Spruce Beetle Infested Acres	Percent of Total Spruce Beetle Infested Acres with 70+ Percent Mortality
Forested land	217,060	100		
Spruce beetle infested since late 1950s	69,000	32	100	
Spruce beetle infested since late 1950s with 70+ percent mortality in spruce	39,000	18	57	100
Spruce beetle infested since late 1950s with 70+ percent mortality in spruce and located with one mile or less of existing roads	15,400	7	22	40
Spruce beetle infested since late 1950s with 70+ percent mortality in spruce and located within one mile or less of existing roads and trails	32,000	15	46	82

Source: USDA Forest Service 1999g.

The spruce beetle infestation on the Kenai portion of the Forest began in the late 1950s and grew at an unprecedented level during the 1980s (Figure 3-16). Management actions to address the beetle infestation has taken place on almost 12,500 acres since 1981, with 59 percent treated by prescribed fire, 37 percent by timber harvest, and 4 percent by timber stand improvement (USDA Forest Service 1999a). There is widespread concern that fire hazard will increase as a result of beetle infestations. Since the beetle outbreak, large woody debris has

accumulated and there has been an increase in grass and other fine vegetation ground cover through which fire spreads rapidly.

Figure 3-16: Spruce bark beetle infestation acreage on the Kenai Peninsula portion of the Chugach National Forest for the years 1957, 1969, and 1976 through 1998.



Source: Chugach National Forest GIS corporate database.

Black-Headed Budworm, (*Acleris gloverana* (Wals)). The black-headed budworm is native to the forests of coastal and southwestern Alaska and is one of the more destructive insects in these forests (Mask 1992). It occurs primarily in Southeast Alaska but in 1996 and 1997, approximately 30,000 acres of defoliation were observed in Prince William Sound and about 1,000 acres on the Kenai Peninsula.

Budworm larva feeding strips hemlock foliage and can cause growth reduction, top-kill, and at times, tree mortality. Localized outbreaks continue to occur throughout the coastal hemlock type in Prince William Sound and Copper River Delta. Budworm populations in Alaska have been cyclic, arising quickly, impacting vast areas, and then subsiding within a few years.

Northern Spruce Engraver (*Ips perturbatus* Eichhoff) – The northern spruce engraver is killing mature as well as pole-sized spruce on the Kenai portion of the Chugach National Forest (Holsten 1998). In addition to standing trees, cut or fallen trees are attacked. Engravers prefer sunnier and drier host material than do spruce beetles (Holsten et al. 1980). Prevention is perhaps the best suppression measure. Preventing slash accumulation, burning infested material, or scattering slash in very sunny locations helps reduce northern spruce engraver buildup (Holsten et al. 1980).

The combined effects of the spruce beetle and northern spruce engraver may increase with the apparent warming trend occurring throughout Alaska (Berg and DeVolder 2001).

Diseases

Diseases are chronic factors that significantly influence the commercial value of the timber resource and alter key ecological processes including forest structure, composition, and succession. The presence of disease in recreation areas can also cause tree failures, which can pose serious safety and liability problems.

At the Forestwide level, the extent and location of diseases is unknown and unmapped. However, disease is a factor in the development of silvicultural prescriptions for project level management activities.

Wood decay fungi decompose branches, roots, and boles of dead trees; therefore, they play an essential role in recycling wood in forests. However, sap rot decay also routinely and quickly develops in spruce trees attacked by spruce beetles. Large amounts of potentially recoverable timber volume are lost annually due to sap rot fungi on the Kenai Peninsula, where salvage logging has not kept pace with tree mortality from the continuing spruce beetle epidemic. Significant volume loss from sap rot fungi typically occurs several years after tree death. The most common sap rot fungus associated with spruce beetle-caused mortality is *Fomitopsis pinicola*, the red belt fungus.

In Southcentral and Interior Alaska, heart, butt, and root rot fungi (Table 3-31) cause considerable volume loss in white spruce forests.

Table 3-31: Common wood decay organisms of live trees in Alaska and tree species infected.

Heart, butt, root rot fungi*	TREE SPECIES INFECTED			
	Western hemlock	Mountain hemlock	Sitka spruce	White/Lutz spruce
<i>Laetiporus sulphureus</i>	X	X	X	X
<i>Phaeolus schweinitzii</i>	X		X	X
<i>Fomitopsis pinicola</i>	X	X	X	X
<i>Phellinus hartigii</i>	X			
<i>Phellinus pini</i>	X	X	X	X
<i>Ganoderma</i> sp.	X		X	X
<i>Armillaria</i> sp.	X	X	X	X
<i>Inonotus tomentosus</i>				X
<i>Heterobasidion annosum</i>	X		X	
<i>Echinodontium tinctorium</i>		X		

* Some root rot fungi were included in this table because they are capable of causing both root and butt rot of conifers.

In the coastal forests of Southeast Alaska, approximately 1/3 of the old-growth timber volume is defective largely due to heart rot fungi. While no studies have been conducted in the old-growth forests of Prince William Sound or Copper River Delta, one could reasonably expect the same level of volume loss to heart rot fungi in these coastal forests of the Forest. Stem decay is the most important cause of volume loss and reduced wood quality in Alaskan hardwood species. In Southcentral Alaska, incidence of stem decay fungi increases with stand age and is generally high in stands over 100 years old. External decay indicators, such as conks, frost cracks, wounds, and broken branches are frequently seen on live

trees with internal decay. There are many stem decay organisms of hardwoods in Alaska, however *Phellinus igniarius* and *Phellius tremulae* are the most common decay fungi of paper birch and aspen, respectively.

Tomentosus root disease (*Inonotus tomentosus* (Fr.) Teng.) is a fungus that causes root and butt-rot of white, Lutz, and Sitka spruce in Southcentral and Interior Alaska. Spruce trees of all ages are susceptible to infection through contact with infected roots. Infected trees exhibit growth reduction or mortality depending on age. In young growth managed stands, planted spruce seedlings may become infected if planted too close to infected root systems of harvested trees (USDA Forest Service and State of Alaska 1999).

Future Trends – Spruce beetle populations on the Kenai Peninsula have been declining since 1996 (Figure 3-15b). Many previous areas of active beetle infestations have been reduced as essentially all available host trees have been killed. Overall, active infestation areas on the Forest have declined by over 50 percent for the second year in a row (USDA Forest Service and State of Alaska 2000) and this trend is expected to continue.

Continued, smaller-scale activity can be expected to persist in areas where suitable host material remains or where new areas of disturbance present beetles with the opportunity for development. Active infestations were recorded in 1999 aerial surveys in the vicinity of Trail Lakes, Granite Creek and along the Sixmile River.

In the future, the greatest potential forest insect and disease effects are likely to be in mature and over mature stands where disease levels are high. Tree vigor tends to decrease with maturity, causing an increase in susceptibility to insects and diseases. Heart rot levels are directly proportional to both tree and stand ages. The spruce beetle has the potential to significantly alter stand structure in certain locations. Stem and root decay have historically increased with intensified land management activities, particularly under harvesting systems other than clearcutting. The adverse effects of these forest insects and diseases, at least in part, can be mitigated through silvicultural treatments.

Methodology and Scientific Accuracy - Pest activity is typically detected during on-the-ground activities, or during annual aerial surveys conducted by the region's Forest Health Protection group. The timing of surveys coincides with foliage and pest development. Pest activity noted during surveys is documented and reported to the appropriate land manager. In cooperation with land managers, Forest Health Protection people conduct on-site investigations to verify the pest, to evaluate the pest and its host(s), and to formulate future management alternatives. Often, pest and host monitoring is required to fully understand potential impacts prior to development of management alternatives.

<h2 style="text-align: center;">Environmental Consequences</h2>

General Effects

The emphasis on management activities to prevent and reduce pest populations or to restore areas already impacted by pest populations varies by alternative. Such emphasis may correspond directly to the proposed levels of vegetation or timber harvesting activities that promote greater habitat diversity. While individually, these management activities may reduce insect and disease in individual stands, it is the cumulative amount of management activity over time on a landscape or the lack thereof, that will determine an alternative's effectiveness.

In general, alternatives that favor low amounts of vegetation or timber management would tend to perpetuate higher levels of susceptibility to insect and disease outbreaks in late successional forests. Ecological processes and late successional wildlife habitat would be maximized, but so would the continued loss of timber, primarily due to high levels of heart rot and on the Kenai Peninsula, spruce beetle. Higher amounts of vegetation management and/or timber harvest would generally yield young stands with little significant insect and disease activity.

In general, endemic levels of insect and disease activity in mature and over mature forests would be allowed to run their course. Timber losses would be acceptable yet harvesting flexibility would be maintained to take advantage of timber salvage opportunities, particularly for dead and dying spruce stands.

Insect and disease suppression may be justified in high quality, mature to over mature stands that cannot be salvaged immediately, or that lie in or near recreation areas and communities where scenic values are high.

Alternatives that increase the amount, extent, or density of mature and over-mature Sitka, white, and Lutz spruce on the Kenai Peninsula would result in increased risk of attack by the major disturbance agent on the Forest, spruce beetles. Tree mortality caused by large-scale outbreaks of insects and disease reduces timber yields, and changes stand structure, species composition, and successional trends. Such changes can enhance diversity by encouraging other plant species, such as paper birch and aspen, and promoting a greater mix of age and size classes; however, the result may not advance efficient timber production goals. Additional effects of widespread tree mortality due to insect and disease activity may include increases in fire hazard, stream flow, and herbage production.

In contrast, alternatives that decrease the amount, extent or density of mature and over-mature Sitka, white, and Lutz spruce on the Kenai Peninsula generally reduce risk of widespread tree mortality caused by insect and disease agents.

Older hardwood stands, especially birch and aspen, currently tend to be heavily diseased, due in part, to the advanced age of many of the trees. Emphasis on enhancing or regenerating hardwood stands could result in more vigorous

vegetation as younger trees vegetate new areas and replace decadent trees, where an emphasis on retaining existing vegetation may perpetuate or increase disease populations.

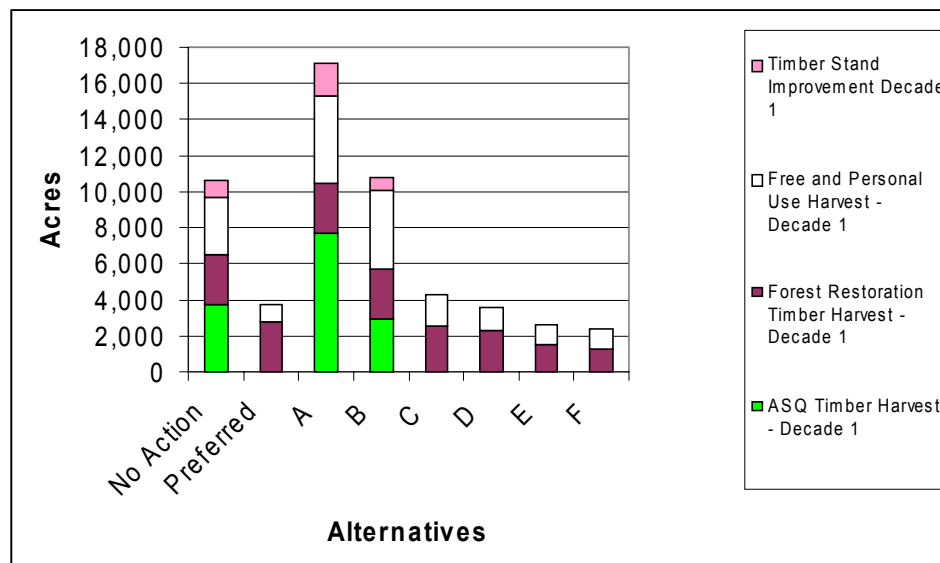
Direct and Indirect Effects

Effects on Insect and Disease Pests from Timber Management

Timber harvesting and timber stand improvement provides an opportunity to implement an ecological approach for the prevention or reduction of serious pest outbreaks. On clearcuts and other final harvest sites, opportunities for long-term protection and prevention of insect and disease outbreaks and restoration of forest health can be managed. Stands most susceptible to insect damage or most infested or infected with disease can be harvested and replaced with young stands that are much less susceptible. In stands scheduled for uneven-aged management, individual suppressed or dying trees can be removed, thus increasing the overall growth and vigor of remaining trees. In commercial or pre-commercial thinnings, susceptibility to insects and diseases may be reduced by increasing the growth and vigor of the remaining trees.

Figure 3-17a shows the cumulative acres that would be treated by timber harvest or stand improvement activities by alternative in the first decade.

Figure 3-17a: Cumulative acres of proposed timber harvest and stand improvement - decade 1.



All alternatives may decrease insect and disease risk at the individual treated stand level. At the landscape level, alternatives that reduce insect and disease risk on the greatest acreage over time would be considered most beneficial. Ranking the alternatives by the acreage of proposed treatment, Alternative A is highest, followed by B, the No Action, C, the Preferred, D, E, and F.

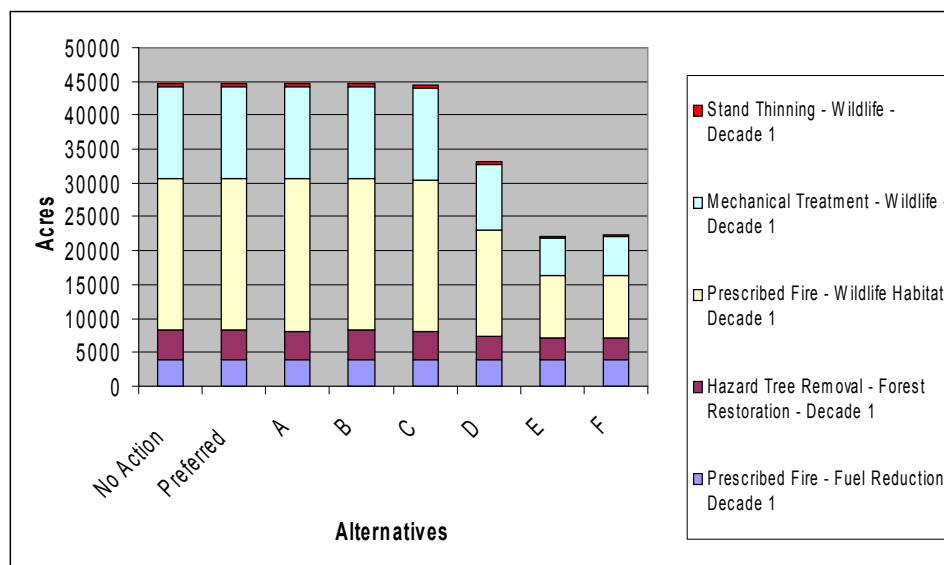
Effects on Insect and Disease Pests from Vegetation Management

Vegetation management can alter both cover type composition and/or structural stage by removing, leaving, or regenerating trees during/after prescribed burning, hazard tree removal, stand thinning, timber harvest, site preparation, and reforestation treatments for fuel reduction, wildlife habitat improvement, insect and disease suppression, forest restoration, recreation or visual resource objectives.

Alternatives that decrease the amount, extent or density of mature and over-mature stands on the Kenai Peninsula generally reduce risk of widespread tree mortality caused by insect or disease pests.

Figure 3-17b shows the cumulative acreage of vegetation that would be treated by activities under the fuels, wildlife, and forest restoration programs by alternative in the first decade.

Figure 3-17b: Cumulative acres of vegetation treated by fuels, wildlife, and forest restoration programs - decade 1.



All alternatives may decrease insect and disease risk in stands treated. At landscape scales, alternatives that reduce insect and disease risk on the greatest acreage would be considered most beneficial. Ranking the alternatives by the amount of treated acres, the No Action, the Preferred, A, B and C all provide the highest level of vegetation treatment and would be most beneficial. The remaining alternatives rank D, F and E with E being the least beneficial.

Effects on Insect and Disease Pests from Administrative Site Management

Costs may be higher than for general forest areas to ensure that vegetation surrounding administrative sites is not degraded due to the activity of insects and disease; however, this would not vary by alternative.

Effects on Insect and Disease Pests from Fire and Fuel Management

In all alternatives, there is an emphasis on fire prevention and suppression in high value timber stands; therefore, their effects on pest populations are not likely to vary significantly between alternatives. The effects of large, high intensity wildland fires on forest pests would likely be to reduce or eliminate those that exist in the affected area, including spruce beetle and possible root rot fungi. Lower burning intensities associated with most wildland fires and prescribed burns can weaken the resistance of trees to pest attacks by damaging root systems and cambial tissues, and might affect levels of root disease and other soil-inhabiting fungi.

In recommended or designated Wilderness, future decisions may allow wildland fires to have a more natural role. This would decrease the susceptibility of older stands to insects and disease. However, decisions will be made on a case-by-case basis.

The proposed fuels reduction program is the same in all alternatives (see Table 3-29) and, therefore, the effects on insect and disease are expected to be the same under all alternatives.

Effects on Insect and Disease Pests from Recreation Management

Alternatives emphasizing the creation of more natural settings and older stands for recreation opportunities or conservation objectives would result in Forest conditions susceptible to certain forest pests, especially spruce beetle.

Management area prescriptions that emphasize wilderness, backcountry recreation, and conservation would have little or no management activity for prevention or reduction of insect and disease pests. Relative rank of alternatives follows the same general order as total number of acres included in the specified management areas. The ability to prevent or mitigate pest epidemics in remote, roadless areas would be difficult.

Pest management activities would be continued or intensified under all alternatives to protect developed recreation complexes and sites. Prudent use of pesticides in high value areas can protect trees from beetle attack and preserve the pleasing setting visitors seek and enjoy. Costs may be higher than for general forest areas to ensure that vegetation in and around developed recreation areas is not degraded or causing a safety hazard due to the activity of insects and diseases. However, this should not vary substantially by alternative.

Effects on Insect and Disease Pests from Riparian Area and Wetland Management

Restrictions on use of pesticides near water may limit some pest management options; however, no significant impacts on pest management in riparian areas or wetlands exist under any of the alternatives. Cost of pest management activities may be higher in riparian areas and wetlands because of more restrictive application requirements. Riparian restoration objectives when implemented under all alternatives may eventually reduce incidence of some insect and disease pests.

Effects on Insect and Disease Pests from Travel Management

The extent of road systems in each alternative determines the ability to access areas where pest populations may be approaching destructive levels or to restore areas already impacted. Alternatives providing the greatest amount of road access generally provide the greatest potential to access and treat acres where pest problems exist. Alternative A, the No Action Alternative and Alternative B provide the highest levels of road access, respectively, while Alternatives C and D, the Preferred Alternative, and Alternatives E and F provide decreasing levels of road access, respectively.

Effects on Insect and Disease Pests from Wildlife Habitat Management

Wildlife management varies by alternative. Prescribed fire would be the primary tool used to create early successional habitat for a number of species on the Kenai Peninsula. Fires may increase vegetative diversity, thereby reducing susceptibility of forest vegetation to insects and disease. Cumulatively, wildlife habitat treatments would treat the largest acreage of mature and over mature forest on the Forest and thus would have the largest impact at the landscape-level in reducing susceptibility to insect and disease pests. See Figure 3-13 for proposed wildlife treatment acreage.

All alternatives may decrease insect and disease risk in stands treated. At landscape scales, alternatives that reduce insect and disease risk on the greatest acreage would be considered most beneficial. Ranking the alternatives by the amount of treated acres, the No Action, the Preferred, A, B and C all provide the highest level of vegetation treatment and would be most beneficial. The remaining alternatives rank D, F and E with E being the least beneficial.

Effects on Insect and Disease Pests from Threatened, Endangered and Sensitive Species Management

The concern for protection of threatened, endangered, and sensitive species plant and animal species will result in specific requirements being incorporated into any activity planned to reduce forest pests where one of the TES species may be present. Concern about these species may result in limited or no action taken to mitigate pests in affected areas. Habitat requirements of some forest-inhabiting sensitive species, such as the goshawk, generally require reductions in human presence and related activities. An active nest could postpone treatment in an area during the nesting season.

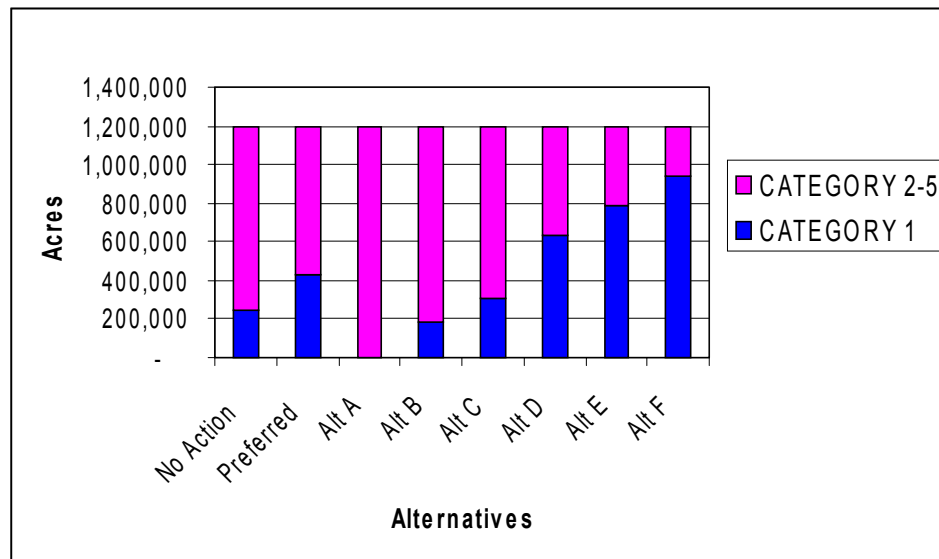
In general, those alternatives that have reduced levels of management activity, that may be more beneficial for mature forest associates, also tend to favor stands that are most susceptible to bark beetle infestations, in particular.

Effects on Insect and Disease Pests from Wilderness, Wild and Scenic Rivers, and Research Natural Areas Management

Category 1 management area prescriptions are land allocations where natural disturbance processes are emphasized. Susceptibility to insect and disease pests would be expected to increase over time in Category 1 areas as forested stands age. Figure 3-18 shows the acres of forested lands in Category 1 management prescriptions by alternative versus Categories 2 - 5 combined.

Alternatives rank according to the acreage allocated in Category 1 prescriptions. Alternatives which would be expected to have the highest level of susceptibility to insect and disease pests over time are F, E, and D, the Preferred, C, the No Action, B, and A, respectively.

Figure 3-18: Acres of forested land on the Chugach National Forest in Category 1 prescriptions by alternative.



Cumulative Effects

Insects and diseases do not recognize property lines. They travel from one ownership to another, generally at a very slow pace. During periods of epidemic levels, such as the 1.3 million acre spruce beetle outbreak, dramatic and rapid Forest change can occur. In the long run, alternatives that enhance a balanced mix of diverse habitats would likely better withstand pressures from various insect and disease pests and will provide greater habitat for beneficial species. Alternatives that emphasize timber production or vegetation management would reduce the average age and density of forest stands, which may reduce spruce beetle epidemics in the future as long as management activity is sustained at similar levels over time.

Alternatives that emphasize more mature and late successional landscapes would likely sustain greater bark beetle damage for a longer period of time before evolving to a more sustainable balance, especially if fire is not present as a primary force in the ecosystem. The degree to which these effects would remain over time would depend largely upon the magnitude of management activities or lack thereof.

If insect and disease outbreaks occur within Wilderness areas or other areas receiving little or no management, they may spread from these areas to areas managed for other resources and threaten the management objectives of the

other areas. Decisions to suppress the outbreaks, to initiate salvage operations where allowed, or to allow the outbreaks to continue will have to be made on a case-by-case basis. This would also affect management activities on lands adjacent to or close to Wilderness.

Figure 3-19 compares the cumulative acreage of management activity on Forestland under the fuel reduction, forest restoration, wildlife, and timber program at the end of the first decade with forestlands that would remain under the influence of natural processes. Figure 3-20 makes the same comparison, but at the end of the fifth decade. Ranking the alternatives by treated acreage, Alternative A is highest followed by B, the No Action, C, the Preferred, D, E, and F, with F being the least beneficial.

Figure 3-19: Cumulative acres of treated and untreated forestland - decade 1.

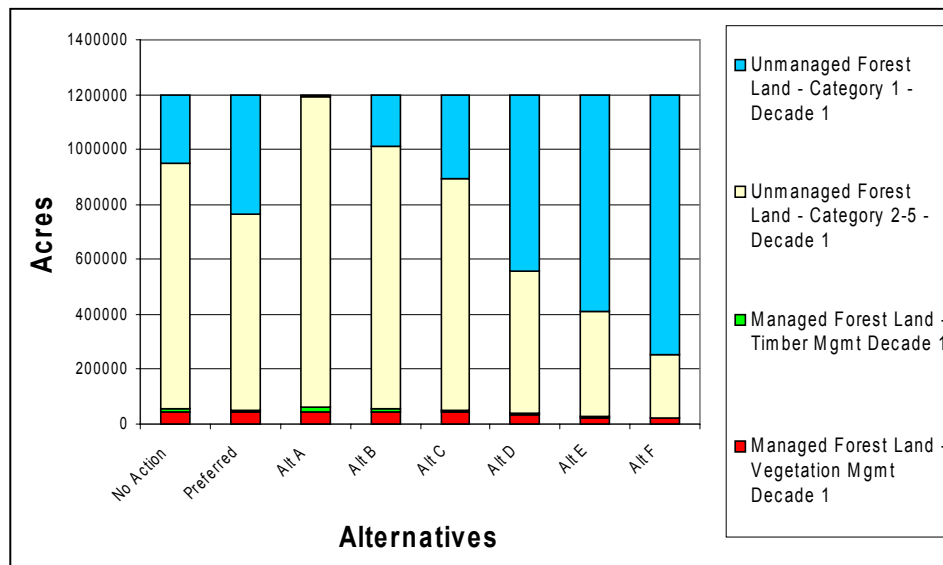
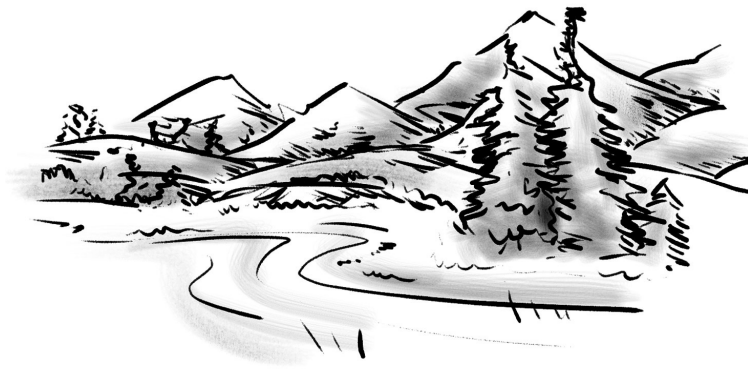
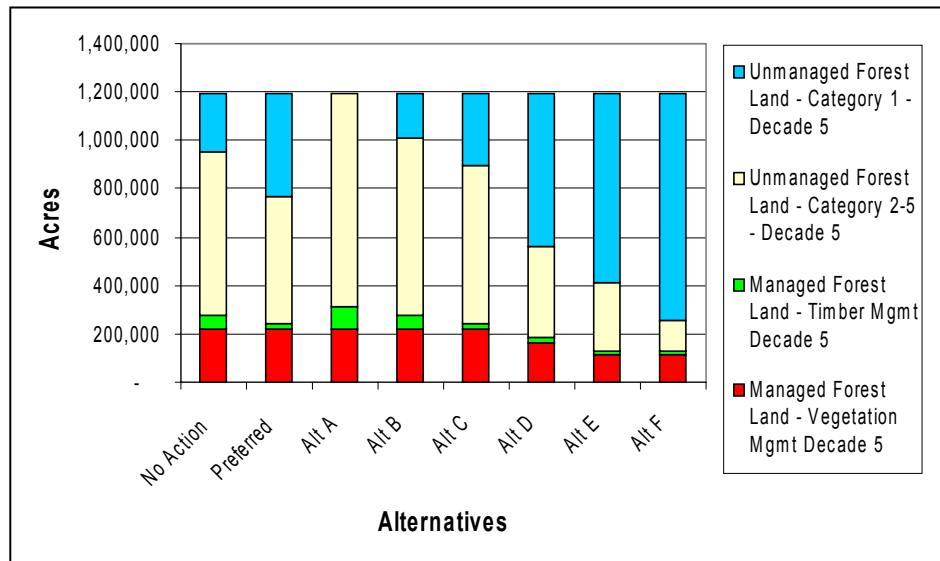


Figure 3-20: Cumulative acres of treated and untreated forestland - decade 5.



Forested Vegetation

Introduction

The forested ecosystems and associated vegetation of the Chugach National Forest are very dynamic. The processes of plant succession and associated disturbance patterns have produced the current vegetative conditions. These natural processes, both part of and necessary for ecosystem function, will continue to produce changes in the future. Therefore, the following description of current forested vegetation represents one point in time. Some of the changes are generally predictable, others less so.

Legal and Administrative Framework

- The **National Forest Management Act of 1976 (NFMA)**
- **Planning Regulations (36 CFR 219)**
- **Ecosystem Management** - In 1992, the Chief of the Forest Service issued a statement committing the Forest Service to the practice of ecosystem management, which is an ecological approach to managing national forests and grasslands for multiple uses.

Key Indicators

- Acres of vegetation treatments
- Acres of forested cover types
- Acres of forest cover type structural stage distribution

Resource Protection Measures

The Revised Forest Plan contains numerous Forestwide and management area prescription standards and guidelines concerning vegetation management. All alternatives provide for satisfactory regeneration of harvest areas, for treatment of activity related fuels, and various wildland fire management strategies needed for resource protection.

Affected Environment

Current Vegetation Composition

Since 1993, a network of 27 forest monitoring plots has been established on the Kenai Peninsula by the Chugach National Forest Ecology Program. The purpose of these plots is the quantification of overstory and undergrowth vegetation compositional changes within forests of the Kenai Peninsula portion of the Chugach National Forest, with emphasis on Lutz spruce (*Picea X lutzii*) forests affected by the spruce bark beetle. Change in canopy composition is occurring as spruce die from spruce bark beetle infestation (Table 3-32a). Understory compositional change is anticipated in response to changes in canopy closure

but these changes are not yet significant. It seems reasonable to expect undergrowth composition changes in plots 93PRM001, 93PRM009, 93PRM010, 93PRM012, and 94PRM013 in future monitoring in response to the indicated changes in overstory composition.

Table 3-32a: Changes in *Picea X lutzii* canopy intercept on 16 of the 27 permanent plots established on the Kenai Peninsula by the Chugach National Forest Ecology Program.

Plot ID	Spruce 1995 Intercept feet	Spruce 1997 Intercept feet	Change in Intercept feet	% Change
93PRM001	67	40	-27	-40
93PRM002	33	29	-4	-12
93PRM003	118	108	-10	-8
93PRM004	157	170	+13	+8
93PRM005	99	103	+4	+4
93PRM006	140	134	-6	-4
93PRM007	101	100	-1	-1
93PRM008	133	134	+1	+1
93PRM009	103	88	-15	-15
93PRM010	86	73	-13	-15
93PRM011	76	72	-4	-5
93PRM012	93	69	-24	-26
94PRM013	154	183	+29	+19
94PRM014	147	152	+5	+3
94PRM015	114	119	+5	+4
94PRM016	128	130	+2	+2

Vegetation on the Forest has also been classified into several cover types, including both forest and non-forest types. The descriptive names used are based on the major canopy species found in each cover type. Many species, other than those listed, also occur in each type. Cover types for the Forest, their acreages, and the percent of the total Forest are listed in Table 3-32b.

Table 3-32b: Cover type composition on the Chugach National Forest.

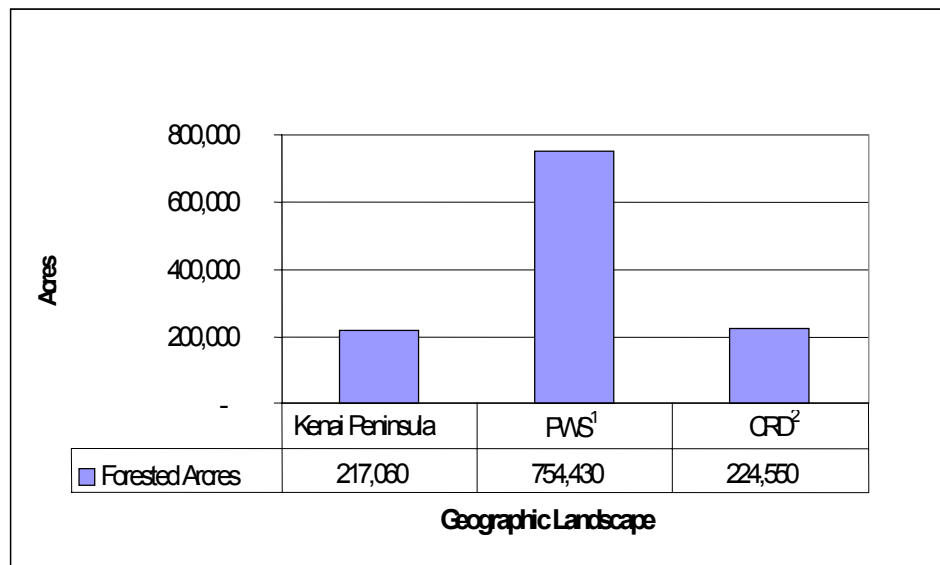
Cover Type	Acres	Percent of Forested Cover Types	Percent of Non-Forested Cover Types	Percent of All Land on CNF
Forested Cover Types				
Aspen	4,350	0.4		0.1
Birch	11,790	1.0		0.2
Cottonwood-Balsam Poplar	23,360	2.0		0.4
Mixed Hardwood-Softwood	14,430	1.2		0.3
Hemlock-Spruce	341,990	28.6		6.2
Hemlock (Western and Mountain)	594,260	49.7		10.8
Black Spruce	580	0.0		0.0
Sitka Spruce	120,530	10.1		2.2
White Spruce	35,600	3.0		0.6
Unclassified	49,150	4.1		0.9
Subtotal Forested Land	1,196,040	100.0		21.8
Non-Forested Cover Types				
Alder and Other Shrubs	473,366		11.0	8.6
Willow	157,870		3.7	2.9
Grasses/Other Alpine Vegetation	508,869		11.8	9.3
Rock/Snow/Ice	780,560		18.2	14.2
Other Non-forested	440,693		10.3	8.0
Water	114,035		2.7	2.1
Unclassified ANILCA/EVOS Additions	1,820,147		42.4	33.1
Subtotal Non-Forested Land and Water	4,295,540		100.0	78.2
Total Chugach National Forest	5,491,580			100.0

Source: Chugach National Forest GIS corporate database.

Collectively, non-forested cover types dominate the landscape of the Forest, accounting for about 78 percent of the gross area. The amount of forested land is about 22 percent (1,196,040 acres). Within the forested component, conifer forest types dominate, accounting for about 91 percent of forested lands, followed by unclassified forest about 4 percent, hardwood forest about 3 percent and mixed hardwood-conifer forest about 1 percent.

Figure 3-21 shows the distribution of forested land between the three geographic landscapes of the Forest. Prince William Sound has 63 percent of the total forested land on the Forest with the remainder almost evenly split between the Copper River Delta (19 percent) and the Kenai Peninsula (18 percent).

Figure 3-21: Forested land distribution by geographic landscape (acres), Chugach National Forest.



¹ Prince William Sound

² Copper River Delta

Source: Chugach National Forest GIS corporate database.

Kenai Peninsula Geographic Area

Needleleaf forests consist of white spruce, Sitka spruce, Lutz spruce (a hybrid of white and Sitka spruce, mapped and summarized as white spruce), mountain hemlock, and occasionally black spruce. Paper birch is the dominant deciduous forest tree and a major component of mixed hardwood-softwood forests. Cottonwood stands are common along valley bottoms and aspen stands occur sporadically on southern-facing side slopes.

Non-forested vegetation on the Kenai includes sub-alpine alder communities and rich herbaceous communities of fireweed, bluejoint reedgrass, and lady fern. Alpine vegetation often consists of dwarf shrub and low herbs including crowberry, luetkea, cassiope, and bog blueberry.

Prince William Sound Geographic Area

Needleleaf forests are dominated by Sitka spruce, mountain hemlock, and western hemlock. Alder and salmonberry dominate Beach fringes and avalanche chutes. Alpine and sub-alpine habitats are less extensive than on the Kenai, with a larger proportion of ice, snow, and rock. Non-forested shrub and herbaceous vegetation commonly includes salmonberry, crowberry, cotton grass, luetkea, bluejoint reedgrass, sedges, and sphagnum mosses.

Copper River Delta Geographic Area

Needleleaf forests include western hemlock and Sitka spruce. Deciduous forests of cottonwoods are common on alluvial surfaces. Forests often occur as narrow stringers between extensive open wetlands. Dominant wetland herbaceous vegetation includes horsetail, buckbean, sedges, bluejoint reedgrass, and

sphagnum mosses. Wetland shrub communities include sweetgale, alder, and willow species. Due to the uplift from the 1964 Alaska Earthquake, the vegetation on formerly inundated lands of the outer Copper River Delta are undergoing rapid successional change, with shrub and tree species becoming more dominant.

Current Forest Structure

Forest structural stages (the developmental stages of tree stands in terms of tree size, age and canopy closure) are used to describe wildlife habitats as well as visual resources. These structural stages are displayed in Table 3-33. Actual age information for the forested stands on the Forest is limited. However, structural stage information can be used as a reasonable substitute for age.

Table 3-33: Forested stand structural stages.

Structural Stage	Description	Dbh Range (Inches)	Age Range (Years)	Canopy Closure Range (Percent)
0	Grass/Forb	Not Applicable	0 - 5	0 - 100
1	Seedling/sapling	0 - 4.9 inches dbh	0 - 5 seedling; 6 - 20 sapling	10 - 100
2	Poletimber	5.0 - 8.9 inches dbh	21 - 80	10 - 100
3	Young Mature (Young-growth Sawtimber)	9.0 - 20.9 inches dbh	81 - 120	10 - 100
4	Old Mature (Old Growth Sawtimber or Late Successional)	21.0+ inches dbh	120+	10 - 100

Structural stage data has not been collected on about 50 percent of the forested land on the Forest and is displayed in Figure 3-22 as “No Data.” This acreage represents unproductive forest in ANILCA additions and/or at higher elevations and is assumed to be in structural stage 2, 3, or 4. Besides the “no data,” structural stage 4 dominates with 34 percent of the total forested acreage, followed by stage 2 (11 percent), stage 3 (4 percent), stage 0 (2 percent) and stage 1 (1 percent).

Figure 3-23 displays the structural diversity within forest types by showing the percentage of available timberlands by forest type and structural stage on the Forest. With the exception of cottonwood forest type, which is almost evenly distributed across all structural stages, the other forest types are predominately in structural stages 3 or 4.

Figure 3-24 displays the acreage distribution of structural stages for all available timberlands on the Forest. Structural stage 4 (late successional, old mature sawtimber) dominates with 66 percent. Structural stages 3 and 4 combined account for 92 percent of the available timberlands while the stages 0, 1 and 2 make up 8 percent.

Figure 3-22: Structural stages of forested lands on the Chugach National Forest.

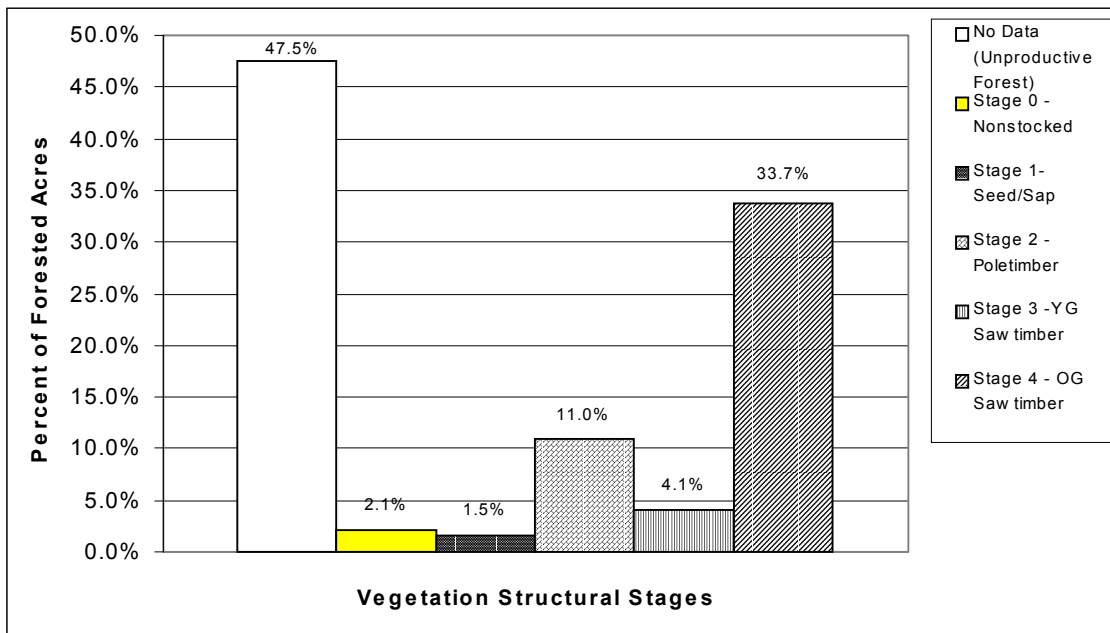
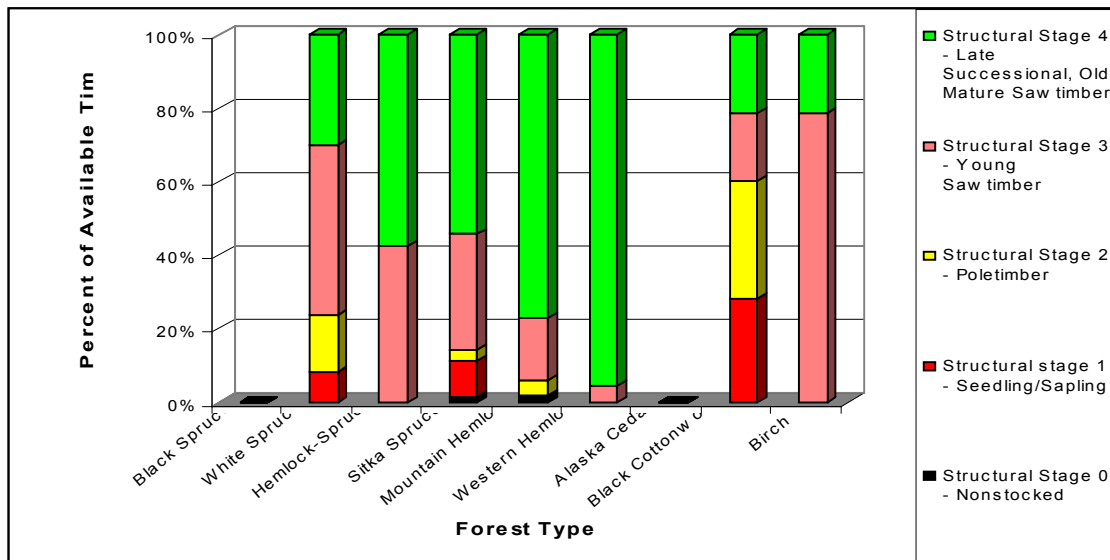
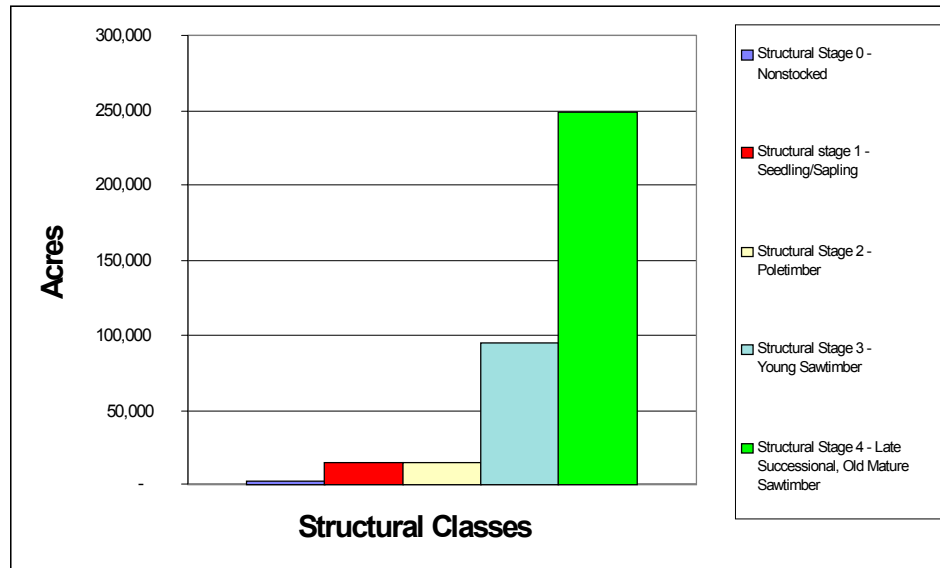


Figure 3-23: Percent of available timberlands by forest type and structural stage on the Chugach National Forest.



Source: Forest Resources of Prince William Sound and Afognak Island, Alaska: Their Character and Ownership, 1978, PNW RB 163 and Timberland Resources of the Kenai Peninsula, Alaska, 1987, PNW RB 180.

Figure 3-24: Acres by structural stage for available timberlands on the Chugach National Forest.



Source: Forest Resources of Prince William Sound and Afognak Island, Alaska: Their Character and Ownership, 1978, PNW RB 163 and Timberland Resources of the Kenai Peninsula, Alaska, 1987, PNW RB 180.

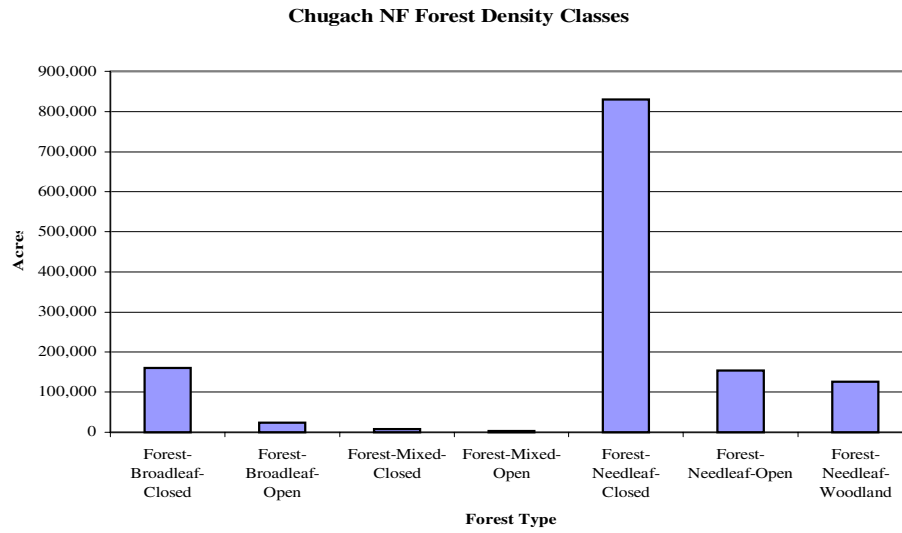
Both vertical and horizontal structural diversity are important to wildlife. Vertical structural diversity increases when there are a variety of layers within a stand. Horizontal structure refers to the spatial arrangement of structurally different stands on the landscape. Horizontal diversity increases when there are a variety of structural stages across the landscape. Conversely, structural diversity decreases when there are few layers within a stand or when landscapes dominated by a particular structural condition have limited horizontal diversity.

Horizontal structural diversity has also been assessed with the Forest satellite land cover type classification. Closed, open, and woodland needleleaf, broadleaf and mixed forest types are summarized in Table 3-34 and Figure 3-25. The forested lands on the Forest are dominated by closed needleleaf forest (almost 64 percent) and closed broadleaf forest (over 12 percent).

Table 3-34: Forest land cover classes of the Chugach National Forest.

Land Cover Class	Percent
Forest-Broadleaf-Closed	12.28
Forest-Broadleaf-Open	1.87
Forest-Mixed-Closed	0.58
Forest-Mixed-Open	0.24
Forest-Needleleaf-Closed	63.59
Forest-Needleleaf-Open	11.79
Forest-Needleleaf-Woodland	9.65
Total	100.00

Figure 3-25: Forest density classes on the Chugach National Forest.



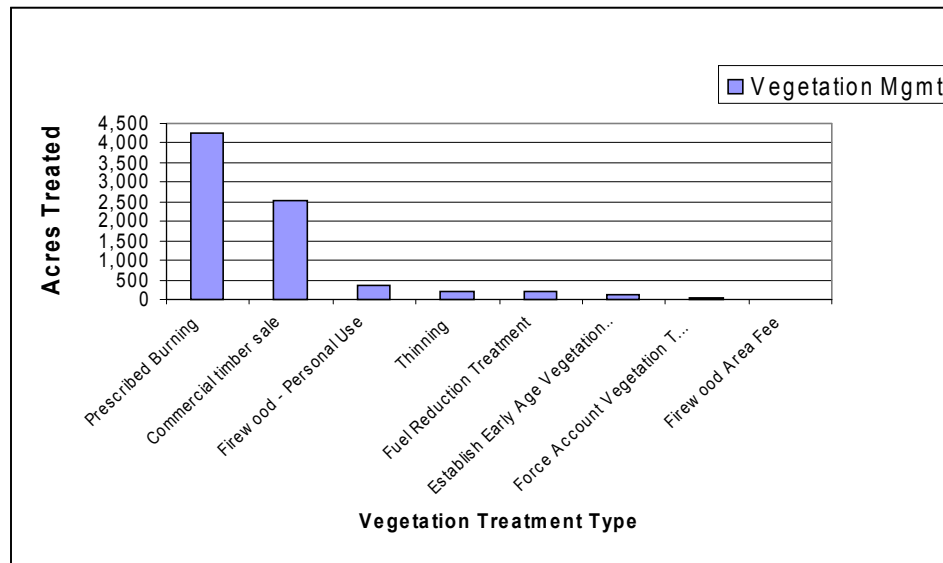
Source: Chugach National Forest GIS corporate database.



Current Management

Since 1974, human disturbance in the form of vegetation management on the Forest has averaged 311 acres per year and has been limited to the Kenai Peninsula in response to the spruce bark beetle epidemic and to improve wildlife habitat through the use of prescribed fire. Figure 3-26 shows the acreage treated by treatment type. Almost 55 percent of all vegetation treatments have been prescribed burns for wildlife habitat. Commercial timber sales have accounted for less than 33 percent of the total vegetation treatments. The total acreage treated (7,785 acres) amounts to 3.6 percent of the total forest on the Kenai Peninsula or 0.7 percent of the total forest on the Chugach.

Figure 3-26: Vegetation management on the Chugach National Forest by activity, 1974-1999.



Environmental Consequences

General Effects

All alternatives provide a variety of vegetation management activities that improve forest health conditions. None of the alternatives would result in significant changes in the existing situation. In all alternatives, the majority of the Forest would continue to be influenced primarily by natural processes.

Natural disturbance events (fire, floods, windstorms, landslides, avalanches, insect and disease outbreaks, etc.) would continue to operate regardless of the alternative. Implementation of any given alternative would influence vegetation by the degree to which natural disturbance events are allowed to operate and according to the levels of various human-caused disturbance events, such as fuel reduction, timber harvest or wildlife habitat improvement.

Cover Types - Forestwide, during the planning period (the next 10-15 years), the majority of forested cover types on the Forest are expected to move through natural succession and become older in all alternatives. In the absence of major disturbance events during the next 50 years, some paper birch and aspen stands on the Kenai Peninsula would slowly be replaced by shade-tolerant hemlock-spruce. As the spruce bark beetle infestation on the Kenai Peninsula continues to take its toll on the remaining mature spruce trees in pure and mixed stands, hemlock, paper birch, young spruce trees, and herbaceous and shrubby vegetation may become more dominant in these stands. The hemlock type on the Forest is expected to maintain itself. In both Prince William Sound and the Copper River Delta, the Sitka spruce and mixed hemlock-spruce types are expected to maintain themselves. Barring large-scale disturbances, succession would continue to move vegetation toward a climax condition. In general, this means that the acreage in late successional species such as hemlock and spruce would increase at the expense of early successional species such as aspen, birch, and/or cottonwood. Other plant communities would also move toward their climax condition. Together, both natural and human-caused disturbance processes would influence plant succession on the Forest. The degree to which succession is influenced depends in large part on the magnitude and type of disturbance.

Structural Stages - As the forest continues to grow, individual forest plant communities would gradually move into more mature stages. Acreage in structural stage 4 would increase as the acreage in structural stages 1, 2 and 3 decreases. This maturation would be accompanied by an increase in crown cover. As a result, the acreage in crown closure classes would also increase in both structural stages 3 and 4. Consequently, total acreage in late successional forest, structural stage 4, would increase with time. Once again, disturbance processes would play a major role in determining future forest structure. When major disturbance events occur, the disturbed area would move into one of the other structural stages. Many of these areas may go to a structural stage 0 or 1.

Direct and Indirect Effects

Effects from Vegetation Management

Vegetation management can alter both cover type composition and/or structural stage by removing, leaving, or regenerating trees during/after prescribed burning, hazard tree removal, stand thinning, timber harvest, site preparation (mechanical or prescribed burning), and reforestation treatments for fuel reduction, wildlife habitat improvement, insect and disease suppression, forest restoration, recreation or visual resource objectives.

The amount of vegetation management proposed during the planning period varies by alternatives and is focused almost exclusively on the Kenai Peninsula under the Forest's "Kenai Peninsula Spruce Bark Beetle Management Strategies & Five-Year Action Schedule" for the spruce bark beetle impacted Kenai Peninsula (USDA Forest Service 1999a). Table 3-35 shows the proposed vegetation management treatment types by alternative for first decade.

Treatments are categorized as being either even-aged or uneven aged silvicultural treatments.

Cover Types – Changes in cover type composition are most likely to occur in the prescribed fire treatments (even-aged) that could decrease the acreage of spruce, mixed hardwood-spruce or mixed hemlock-spruce cover types while increasing the acreage in the early successional cover types of paper birch or aspen. Mechanical treatment (even-aged) of birch and aspen cover types for wildlife objectives is not expected to result in cover type changes. Uneven-aged treatments (hazard tree removal and stand thinning for wildlife) along with even-aged reforestation treatments are not expected to result in cover type changes.

Table 3-35: Acres of vegetation treatments by alternative (M¹ acres) - decade 1.								
Vegetation Management Treatments	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Prescribed Fire – Fuel Reduction ²	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Prescribed Fire - Wildlife								
Early Successional Species	21.50	21.50	21.50	21.50	21.50	14.90	8.70	8.80
Sheep/Goat	0.63	0.63	0.63	0.63	0.63	0.44	0.26	0.26
Brown Bear	0.30	0.31	0.30	0.30	0.30	0.21	0.12	0.12
Spruce Dependent Species	0.05	0.05	0.05	0.05	0.05	0.03	0.02	0.02
Total Wildlife Prescribed Fire	22.48	22.49	22.48	22.48	22.48	15.58	9.10	9.20
Total ALL Prescribed Fire	26.48	26.49	26.48	26.48	26.48	19.58	13.10	13.20
Mechanical (Non-TES Species)	13.55	13.55	13.55	13.55	13.55	9.75	5.69	5.78
Mechanical (TES Species)	2.50	2.50	2.50	2.50	2.50	1.52	0.89	0.90
Total Mechanical - Wildlife	16.05	16.05	16.05	16.05	16.05	11.27	6.57	6.68
Hazard Tree Removal	4.18	4.18	4.18	4.18	4.01	3.48	3.18	3.18
Stand Thinning/Pruning/ Pest Mgmt - Wildlife	0.54	0.38	0.54	0.54	0.54	0.37	0.21	0.23
Total Stand Improvement	4.72	4.56	4.72	4.72	4.55	3.85	3.39	3.41
Reforestation								
Reforestation – Forest Restoration	7.32	7.32	7.32	7.32	7.32	5.84	5.00	4.73
Reforestation – Fish and Wildlife	18.02	17.57	18.02	18.02	18.02	17.77	17.54	4.46
Total Reforestation	25.34	24.89	25.34	25.34	25.34	23.61	22.54	9.19
Grand Total All Treatments	72.59	71.99	72.58	72.59	72.42	58.23	45.56	32.43

¹ thousands of acres

² Based on "Spruce Bark Beetle Management Strategies & Five-Year Action Schedule, (USDA Forest Service 1999a).

Alternatives with the greatest potential to change cover types are those with the highest amounts of prescribed fire. The No Action Alternative, the Preferred Alternative, and Alternatives A, B, and C all have equal amounts of prescribed fire and therefore the greatest potential for conversion of cover types on the treated acreage. Alternatives with the least potential for cover type conversion in decreasing order are D, F and E.

Structural Stages – Changes in structural stages are associated with treatments under even-aged management. Uneven-aged management that removes hazard trees or thins stands for wildlife objectives are not expected to alter the structural stages of forested stands. The No Action Alternative, the Preferred Alternative, and Alternatives A, B and C have equal amounts of even-aged treatments and have the highest potential for changing structure from a stage 3 or 4, to a stage 0 or 1 by the respective acreage treated. Having the least potential for structural changes in decreasing order are D, F and E.

Effects from Fire Management

Fires are almost nonexistent in two of the three geographic landscapes, Prince William Sound and the Copper River Delta, due to wet climatic conditions. Consequently, no effects from fire management are predicted for these two areas.

On the Kenai Peninsula, fires, both wildland and prescribed, can and have altered forest composition by increasing abundance of pioneer species such as paper birch and aspen while reducing later successional species such as hemlock and spruce. Structural post-fire changes depend on the existing conditions and the type of fire. Cool ground fires would primarily reduce spruce and hemlock seedlings, saplings and ground litter. Very hot, stand-replacing fires can reset stands back to structural stage 0 (grass/forb), completely changing stand structure. Most fires burn in a mosaic pattern, ranging from untouched mature to the grass/forb stage. Planned fires can influence forest processes by reducing the hazard and intensity of subsequent fires.

As displayed in Table 3-39, the use of prescribed fire for fuel reduction objectives would treat 400 acres annually or 4,000 in the first decade. The amount is the same under all alternatives and therefore the effects would be the same under all alternatives.

Cover Types – With 4,000 acres of prescribed fire in the first decade, some cover type changes from spruce, mixed hemlock-spruce, or mixed hardwood-spruce cover types to birch, aspen, cottonwood, mixed hardwood, grass/forb or shrub cover types are expected. The amount of change is difficult to predict due to the number of variables involved. The maximum scenario under all alternatives would be a net reduction of 4,000 acres of conifer cover types, with a corresponding increase of 4,000 acres in hardwood cover types and/or grass/forb, or shrub cover types at the end of the first decade.

Structural Stages – Prescribed fire for fuels reduction in forested stands would result in moving some stands from late successional (stage 4) to early successional stages (stage 0 or 1). At the end of the first decade, assuming all

400 acres were completely burned each year, 2,000 acres of structural stage 4 forest would have moved to stage 1 (acres burned in the first five year period) and 2,000 acres would have moved to stage 0 (acres burned in the second five year period) for a net decrease of 4,000 acres in structural stage 4 forest.

Effects from Recreation

Recreation is expected to increase under all alternatives. Recreation in developed sites with fire grates, can lead to a reduction in fuelwood sources, (snags and down woody material). This can extend outside the confines of the site, but is usually small in scale.

Repetitive concentrations of people can lead to soil compaction, physical injuries to trees, trampling of shrubs, grass, and forbs, and result in increased susceptibility of these plants to mortality. In riparian zones, loss of vegetative cover can destabilize stream banks. Winter recreation, including snowmobiling and skiing, compact snow and slow melting in the spring. This in turn can have an effect on vegetation under or near the areas of compaction. Snowmobilers and, to a lesser degree, skiers can also cause physical damage to trees not covered by the snow pack. In general, the effects from recreation described above occur in isolated areas of heavy use and are not significant at the Forestwide level.

The main effects on forest cover types and structural stages from recreation would result from tree removal during construction or expansion of facilities such as campgrounds, trails, trailheads, interpretive sites, and recreation roads. Depending on the activity, effects on cover type and structure range from no effect to conversion of forest cover types to nonforest cover types (see effects from roads and trails discussed under access management in this section). Overall, no significant changes to Forestwide cover types or structural stages are expected in any alternative.

Effects from Wildlife Management

As displayed in Table 3-39, the majority of planned activities to benefit wildlife species would be prescribed fire to create or improve habitat for species that benefit from early successional cover types. The effects from wildlife management vary by alternative according to the proposed treatments for wildlife habitat improvement in Table 3-39.

Cover Types – Out of the total vegetation treatments for wildlife, only prescribed fire treatments for early successional habitat enhancement is expected to result in a change in cover types from late successional cover types to early successional types by the respective acreage treated. Prescribed fire for sheep/goat, brown bear and spruce-dependent species are not expected to change cover types. Burns for sheep/goat would be mostly in timberline stands and/or alpine cover types while burns for brown bear and spruce-dependent species would be reforested back to spruce. The No Action Alternative, the Preferred Alternative, and Alternatives A, B, and C have equal amounts of early successional prescribed fire and would have the greatest amount of change while the alternatives with the least amount in decreasing order are D, F and E.

Structural Stages - Changes in structural stages are associated with treatments under even-aged management. Uneven-aged management that removes or thins stands for wildlife objectives are not expected to alter the structural stages of forested stands. The No Action Alternative, the Preferred Alternative, and Alternatives A, B, and C have equal amounts of even-aged treatments and have the highest potential for changing structure from a stage 3 or 4 to a stage 0 or 1 by the respective acreage treated. Having the least potential for structural changes in decreasing order are D, F, and E.

Effects on Threatened, Endangered, Sensitive Species (TES) Management

In general, habitat requirements in and around each known or discovered TES location will be protected, restored, or enhanced. As displayed in Table 3-39, mechanical treatment to benefit TES wildlife species varies by alternative ranging from a low of 890 acres in Alternative E to a high of 2,500 acres in the No Action Alternative, the Preferred Alternative, and Alternatives A, B and C during the first decade.

Cover Types – Mechanical treatments for TES wildlife species are not expected to result in any significant cover type changes under any of the alternatives.

Structural Stages – Some change in structural stage on a portion of the treated acreage is expected, but the exact amount would depend on the site-specific conditions of the TES habitat. Overall, structural change resulting from mechanical treatments is expected to be insignificant under all alternatives.

Effects from Mineral Exploration and Development

Development of access roads and ground-disturbing mineral exploration may affect some forest stands. Because the potential for intensive development of locatable or leasable minerals is considered to be low in all alternatives, no significant changes to Forestwide cover types or structural stages are expected.

Effects from Heritage Resource Management

Vegetation management can be precluded due to the significance of a site. In these cases, trees on the site would mature, reproduce and eventually die. Excavations can reduce vegetative cover, especially in the understory. No significant changes to Forestwide cover types or structural stages are expected in any alternative.

Effects from Access Management

Road construction can lead to changes in plant species composition due to modifications in site conditions. Vegetation along the road corridors may be stressed due to changes in site conditions that contribute to increases of certain insect and disease pests. However, roads provide access for conducting forest pest management activities to reduce or prevent damage caused by insect and disease pests.

Roads and trails can function as firebreaks, reducing the fire hazard. Suppression capabilities are improved in areas with road access. Fire risks increase in relation to the number of people using an area. Therefore, available road densities enhance fire suppression and while increasing fire risk.

Road obliteration would increase vegetative cover. Left alone these areas would eventually revert back to the surrounding vegetation.

The majority of impacts to forest vegetation from travel management would result from vegetation alterations during the construction and reconstruction of roads and trails to meet access management objectives. The estimated acreage that would be converted to roads and trails after the first decade is displayed in Table 3-36.

Table 3-36: Acres of vegetation converted to roads and trails by alternative - decade 1.

	Alternative						
	No Action	Preferred	A	B	C	D	E
Roads	405	199	690	608	173	134	97
Trails	38	105	101	113	135	107	51
Total	443	304	791	721	308	241	149

Most of the above acreage would be located in forested stands that would be converted and maintained as non-forest roads and trails, with corresponding net reductions in both forest cover types and structural stages. Forestwide, the amount under all alternatives is insignificant.

Effects from Utility Corridors and Electronic Sites

Vegetation management within existing utility corridors is designed to keep trees from reaching suspended lines. Within forested communities, the overstory is suppressed by removing trees. This alteration in site conditions can lead to changes in species composition. Trees that regenerate within the corridor are cut before they pose a problem to the lines. While the cover type is generally not changed, structure within the corridor is primarily seedling/sapling, while adjacent areas may retain mature forest conditions. Electronic sites generally have no effect on forested communities due to their placement on mountaintops.

Fire hazards are reduced where corridors or road access to corridors or electronic sites bisect forest communities, due to the breakup of fuel continuity. The risk of fire ignitions is increased because of the potential for downed power lines and/or improved access for people. Surface disturbance from line construction, tree removal and vehicle access also increases the potential for fire ignitions.

Some forested stands would be converted and maintained as early structural stage vegetation during development. This allocation would reduce the increase of acreage of younger structural stands and sharply define edges between the utility right-of-way and adjacent areas. Due to the small acreage allocated to this use, Forestwide impacts are expected to be minor in all alternatives.

Effects from Timber Management

Table 3-37 shows the acreage treated by alternative during the first decade under the timber management program. Treatments are categorized as being either even-aged or uneven-aged silvicultural treatments. Only the No Action Alternative and Alternatives A and B have a suitable timberland base that contributes to the allowable sale quantity.

Cover Types – No significant changes to cover type acreages are anticipated under any alternative.

Structural Stages – The majority of forested acres would be managed through natural disturbance processes rather than through active silvicultural treatments. Uneven-aged silviculture in all alternatives and stand thinning in Alternative A, the No Action Alternative and Alternative B is not expected to change the structural stage of treated stands in any of these alternatives.

The greatest impact to structural stage is expected to result from even-aged silvicultural treatments in the hemlock, spruce and hemlock-spruce cover types within the suitable timberlands in Alternative A, the No Action Alternative and Alternative B. Because of the small acreage planned for active treatments, Forestwide, stands would continue to age and acreages in structural stages 3 and 4 are expected to increase in all alternatives. Structural stages 0, 1 and 2 would continue to make up relatively low percentages for all cover types across the forest at the end of the first decade.

Table 3-37: Acres of timber harvest treatments by alternative (M¹ acres) - decade 1.

Timber Harvest	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Timber Harvest Even-Aged								
Even-Aged Management (ASQ)	2.96	0	6.17	2.34	0	0	0	0
Even-Aged Management - Forest Restoration	0	0	0	0	0	0	0	0
Even-Aged Management - Free and Personal Use	0	0	0	0	0	0	0	0
Total Even-Aged Management	2.96	0	6.17	2.34	0	0	0	0
Timber Harvest Uneven-Aged								
Uneven-Aged Management (ASQ)	0.74	0	1.54	0.58	0	0	0	0
Uneven-Aged Management - Forest Restoration	2.77	2.77	2.77	2.77	2.57	2.28	1.48	1.30
Uneven-Aged Management - Free and Personal Use	3.24	0.98	4.82	4.35	1.69	1.27	1.12	1.05
Total Uneven-Aged Management	6.75	3.75	9.13	7.70	4.26	3.55	2.60	2.35
Total Timber Harvest	9.71	3.75	15.30	10.04	4.26	3.55	2.60	2.35
Site Preparation								
Mechanical	0.95	0	1.8	0.75	0	0	0	0
Prescribed Fire	2.33	0.90	3.67	2.41	1.02	0.85	0.62	0.56
Total Site Preparation	0.58	0.23	0.92	0.60	0.26	0.21	0.16	0.14
Reforestation								
Reforestation – Natural	7.28	2.81	11.48	7.53	3.20	2.66	1.95	1.76
Reforestation – Planting	5.82	2.25	9.18	6.02	2.56	2.13	1.56	1.41
Total Reforestation	13.10	5.06	20.66	13.55	5.75	4.79	3.51	3.17

¹ thousands of acres

Cumulative Effects

The cumulative effects for forest vegetation consider lands within the boundaries of the Chugach Forest. The majority of forested vegetation within the cumulative impacts assessment area occurs on the Forest. A complete set of forest cover type and structural stage data is not available for other landowners within the boundary of the Forest, and thus is not available for this cumulative effects analysis. Most non-National Forest System forested lands within the assessment area belong to three major landowners: the State of Alaska, the Kenai Peninsula Borough, and regional and village native corporations. Based on current and projected market conditions for timber, post-oil spill restoration and recovery in Prince William Sound, and social, human-related disturbance on non-National Forest System lands within the Forest boundary during the planning period is estimated to be insignificant in the context of the land base within the Forest boundary.

On National Forest System lands within the assessment area, Tables 3-38 and 3-39 show the estimated cumulative effects of human-related disturbance on forest cover types and structural stages in the first decade that may result from implementing the revision alternatives. Effects on cover types and structural stages from natural succession were not estimated for the first decade, but are assumed to be minimal in such a short time period.

Cover Types - Table 3-38 shows the estimated change in forest cover type acres by alternative that may result from the human-related disturbance activity during decade 1 under full funding implementation. The greatest overall impacts on forest cover types may result from prescribed burning for wildlife habitat improvement. The potential cumulative change in forest cover types is highest in Alternative A followed in decreasing order, by Alternative B, the No Action Alternative, Alternative C, the Preferred Alternative, and Alternatives D, F, and E.

Table 3-38: Estimated acreage change in forest cover type by alternative (M* acres) – decade 1.

Human Disturbance Activity	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Roads and Trails	0.44	0.30	0.79	0.72	0.31	0.24	0.15	0.10
Prescribed Fire - Fuel Reduction	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Prescribed Fire - Wildlife (Early Successional Habitat)	21.50	21.50	21.50	21.50	21.50	14.90	8.70	8.80
Total Acres Resulting in Change	25.94	25.80	26.29	26.22	25.81	19.14	12.85	12.90
Percent of Forest Cover Types	2.2%	2.2%	2.2%	2.2%	2.2%	1.6%	1.1%	1.1%

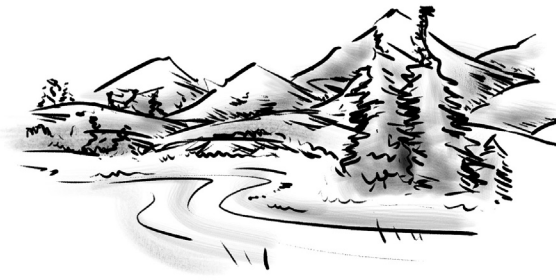
* Thousands of acres

Structural Stages - The majority of forested acres on the Chugach Forest would be managed through natural disturbance processes during the planning period rather than through active silvicultural treatments. Within suitable timberlands for the No Action Alternative and Alternatives A and B, 20 percent of the timber harvest would be uneven-aged silvicultural treatments, which are not expected to change the structural stage of the treated stands.

Table 3-39 shows the estimated change in forest structural stage acres by alternative that may result from the human-related disturbance activity during the first decade. The greatest overall impacts on structural stages may result from prescribed burning for wildlife habitat improvement. The potential cumulative change in forest cover types is highest in Alternative A, followed in decreasing order by No Action, B, C, Preferred, D, F, and E.

Table 3-39: Estimated acreage change in structural stage by alternative – decade 1.

Human Disturbance Activity	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Roads and Trails	0.44	0.30	0.79	0.72	0.31	0.24	0.15	0.10
Prescribed Fire - Fuel Reduction	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Prescribed Fire - Wildlife (Early Successional Habitat)	21.50	21.50	21.50	21.50	21.50	14.90	8.70	21.50
Prescribed Fire - Sheep/Goat	0.63	0.63	0.63	0.63	0.63	0.44	0.26	0.26
Prescribed Fire - Brown Bear	0.30	0.31	0.30	0.30	0.30	0.21	0.12	0.12
Prescribed Fire - Spruce Dependent Species	0.05	0.05	0.05	0.05	0.05	0.03	0.02	0.02
Mechanical Treatment Wildlife - Non-TES	13.55	13.55	13.55	13.55	13.55	9.75	5.69	5.78
Timber Harvest Even-Aged (ASQ)	2.96	0	6.17	2.34	-	-	-	-
Total Acres Resulting in Change	43.43	40.34	46.99	43.09	40.34	29.57	18.94	19.08
Percent of Forest Cover Types	3.6%	3.4%	3.9%	3.6%	3.4%	2.5%	1.6%	1.6%



Plants

Introduction

The complex geology, varied climate, and periodic disturbances of the habitats of Southcentral Alaska and the Chugach National Forest have resulted in a diverse flora. This flora ranges from the Gulf of Alaska shorelines and wetlands of the temperate rain forest to the ice-clad Chugach and St. Elias Mountains. Some of these mountains are more than 10,000 feet high. Most plant species on the Chugach National Forest are widely distributed and common. However, some plants are of limited distribution and abundance, several of which may be locally or globally rare.

Legal and Administrative Framework

- The **National Forest Management Act of 1976 (NFMA)** states that the forest plan must “provide for the diversity of plant and animal communities based on the suitability and capability of the specific land area.”
- **Ecosystem Management** - In 1992, the Chief of the Forest Service issued a statement committing the Forest Service to the practice of ecosystem management, which is an ecological approach to managing national forest and grasslands for multiple purposes.
- The **Endangered Species Act of 1973** governs the protection of listed species and the ecosystems upon which they depend.
- The **Forest Service Manual (2672)** requires the Regional Forester to identify sensitive species occurring within the region.
- The **Forest Service Manual (2672.4)** requires that a biological evaluation (BE) be prepared for all Forest Service activities to address impacts to Forest Service sensitive species.
- **36 CFR 219.27 (g)** states that management prescriptions, when appropriate and to the extent practicable, shall preserve and enhance the diversity of plant and animal communities.

Key Indicators

- Distribution of potential sensitive plant habitat by prescription category.

Resource Protection Measures

Federal regulations require that viable and well-distributed populations of all native (and desirable non-native) species be maintained across the national forest. All management activities on national forest lands will be evaluated in order to assure the protection of all rare plant species and their habitats. Rare plant inventory and monitoring will document the presence or absence of rare

plants, find plants new to the Chugach National Forest and more clearly define their habitat and distribution.

Affected Environment

Sensitive Plants

All the vascular plants known or suspected to occur on the Chugach National Forest were reviewed to develop a list of plants to discuss in this section. This subset of the Alaskan flora was further filtered to select a set of plants with potential conservation concerns.

This list of plants with potential conservation concerns includes all plants listed on the Alaska Region sensitive species list that are known or are suspected to occur in the Chugach National Forest. The Regional Forester has designated as sensitive those plants that could trend toward listing under the Endangered Species Act.

Also included are many plants designated by the Alaska Natural Heritage Program as G1-G3, S1-S2 known from or suspected to occur in the Chugach National Forest. Definitions of the rankings are shown following Table 3-40.

Other plants with potential viability concerns within the Chugach National Forest are included. Some of these plants could be common elsewhere, however the edge of their range is known to be or suspected to be in the Chugach Forest Area, or disjunct populations of the plants are known from the Chugach National Forest. The National Forest Management Act addresses concerns about population viability through the requirement that national forests maintain viable populations of species throughout their range.

Since so little is known about some of these plants, habitat information is limited to the data taken from the labels of herbarium specimens. In many instances this habitat information is very general. During the past several years, plant surveys have filled gaps in habitat and distribution information and provided information to botanists who are evaluating the taxonomy of these plants. Consequently, some of the plants previously considered to be rare have been found to be more common than previously thought, and the taxonomic status of others has been changed. Future revisions of the Alaska Region sensitive species list will reflect these changes in distributional and taxonomic information.

The body of this section is a table (Table 3-40) displaying general information about the Chugach National Forest's plants with potential conservation concerns. Information includes: scientific name; Alaska Natural Heritage ranking; and a column with an "S" or "C." Alaska Region sensitive plants are indicated with an "S," and plants being analyzed on account of viability concerns are indicated with a "C." Also shown are rangewide distributions, Chugach National Forest distribution and habitat. In addition, for each plant, there are ecological data that can be tied to one or more bioenvironmental classes, which were developed by

Rob DeVelice (Forest Ecologist); these classes are in the columns labeled Bioclim, Covtype and Landtype. Using these classes, inferences can be made to estimate where habitat for each plant might occur on the Forest.



Environment and Effects 3

Table 3-40: Vascular plants with potential viability concerns known or suspected to occur on the Chugach National Forest.

PLANT NAME	G RANK	S RANK	S/C	RANGEWIDE DISTRIBUTION	CHUGACH NF DISTRIBUTION	HABITAT	BIO CLIM	COV TYPE	LAND TYPE
<i>Adiantum aleuticum</i>	G5	S3S4	C	Prince William Sound disj S along Cordillera, to CA-AZ, scattered in E North America.	NW edge of range in insular PWS, Cordova area. Chugach populations disj from populations to east.	Moist forested ravines, wet cliffs, rock faces, talus slopes, alpine, and subalpine meadows.	1,2,3, 4,5,6, 7,8	1,2,3, 4,5	3,4,5
<i>Agrostis thurberiana</i>	G5	S2	C	Unimak area, disj E across south coastal AK to Chugach, disj SE to Cordillera.	NW edge of the range near Chugach. Disj. population on Kenai Peninsula.	Alpine meadows, bogs, stream margins, lake margins.	2,3,6	1,2,5	2,3
<i>Anemone multifida</i> var. <i>saxicola</i>	G5T4 T5	S3S4	C	Chugach area, SE to CO.	West edge of range on Kenai.	Rocky slopes, meadows, well drained soil, gravelly areas.	3,4,5, 6	4,5	2,3
<i>Aphragmus eschscholtzianus</i>	G3	S3	S	Aleutians E across southern AK through southwest Yukon. Regional endemic.	Kenai Peninsula, suspected to occur in mountainous areas throughout the Chugach.	Moist mossy areas, solifluction slopes, near rivulets in alpine seeps, heaths and scree slopes in the subalpine and alpine.	5,6	5	2
<i>Arnica diversifolia</i>	G5	S1	C	Kenai Peninsula, SE along Cordillera, S to CA.	SW edge of range on Kenai Peninsula.	Rocky gravelly areas, open areas, grassy meadows, mountains, mixed herbaceous meadows.	6	5	2
<i>Arnica lessingii</i> ssp. <i>norbergii</i>	G5T2 Q	S2	S	Kenai Peninsula, disj E through N southeastern AK. Regional endemic.	Several populations in the Portage area. Unakwik Inlet. Evans I., Cordova area.	From sea level to subalpine in well drained meadows, shrublands, dry meadows, forest openings and open forest.	1,3,4, 6	1,2, 3,4,	2,3,4,
<i>Artemisia tilesii</i> var. <i>unalaschcensis</i>	G5T3	S3	C	Endemic to southwest AK, disj on Seward Peninsula.	E edge of the range in PWS.	Well-drained areas, sandy soil, alpine, lowlands.	1,2,3, 4,5,6, 7,8	3,4,5	2,3,4, 5
<i>Botrychium ascendens</i>	G3?	S1	C	Widely disj in W NA.	Suspected to occur on Chugach.	Beach meadows sandy areas. Mesic to dry meadows in the alpine.	3,4,6, 7,8	2,4,5, 6	2,3,4, 5
<i>Botrychium virginianum</i>	G5T5	S1S2	C	Across NA, South America, Eurasia.	NW edge of the range in PWS.	Shrubby grassy areas, thickets, upper beach meadows.	1,2,3, 4	1,2,3, 4	4,5
<i>Botrychium new 2x</i>	G1	S1	C	Yakutat area, suspected to the NW.	Suspected to occur on Chugach.	Beach meadows sandy areas, open turf or gravelly slopes, shores or meadows.	1,2,3, 4,8	3,4,5, 6	4,5

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Table 3-40: Vascular plants with potential viability concerns known or suspected to occur on the Chugach National Forest.

PLANT NAME	G RANK	S RANK	S/C	RANGEWIDE DISTRIBUTION	CHUGACH NF DISTRIBUTION	HABITAT	BIO CLIM	COV TYPE	LAND TYPE
<i>Botrychium new 4x</i>	G1	S1	C	Yakutat area, suspected to the NW.	Suspected to occur on Chugach.	Beach meadows sandy areas, open turf or gravelly slopes, shores or meadows.	1,2,3, 4, 8	3,4,5, 6	4,5
<i>Carex athrostachya</i>	G5	S1S2	C	Southcentral and coastal AK, S to CA, UT, CO.	Disj. populations near Chugach.	Wet meadows, lowlands to moderate elevations.	1,2,3, 4,6,7	3,4	3,4,5
<i>Carex lenticularis</i> var. <i>dolia</i>	G5T3 Q	S3	S	Aleutians E to Kodiak I., E to the Alaska-Canada Coast range, through the Rocky Mts. south to Glacier National Park.	Kenai Peninsula, insular PWS, to be expected elsewhere in the Chugach.	Wet meadows, along lakeshores and snowbeds, generally at high elevations, subalpine, alpine.	1,2,3, 4,6,7	1,2,3, 4,5	2,3,4
<i>Carex phaeocephala</i>	G4G5	S1	C	Neacola Mts., W of Cook Inlet, along coast, SW to the Yukon, S along Cordillera.	At NW edge of range. Kenai Peninsula.	Wet meadows, rocky alpine slopes.	2,4,5, 6,7	3,4,5	2,3
<i>Carex preslii</i>	G4	S1	C	Kenai Peninsula, E and S along coast to CA and MT.	W edge of range on Kenai Peninsula.	Meadows.	6	1	4
<i>Carex ramenskii</i>	G4Q	S4	C	E Asia E to arctic, W and Southcentral AK.	E edge of range at Copper River Delta.	Coastal salt marsh, brackish water, beaches at high tide.	1,3	1,4,6	4,5,6
<i>Carex stipitata</i>	G5	S1	C	Japan disj. to southern AK, S to CA, and east across NA.	populations on Kenai Peninsula from Asia and Southeast Alaska.	Swamps and meadows, pond edges, wet low ground.	1,3,4	1,2,3, 4	3,4,5
<i>Castilleja parviflora</i>	G4	S2S4	C	Coastal, Kenai S to Oregon. NWC endemic.	W edge of the range in Chugach.	Alpine and subalpine meadows.	2,4,5, 6	3,4,5	2,3
<i>Coptis asplenifolia</i>	G4G5	S3S4	C	Coastal, PWS to Washington. NWC endemic.	NW edge of range in eastern PWS.	Bog edges, mixed conifer forests, open forests.	1,2,3, 4	1,2,3, 4	3,3,5
<i>Crataegus douglasii</i> var. <i>douglasii</i>	G5T4	S1S2	C	PWS disj. to Southeast AK, disj. to NW, disj. to Great Lakes.	W edge of the range in PWS, and disj. population.	Forest edge.	1,3,4	1,2,3, 4	3,4,5
<i>Dactylorhiza aristata</i>	G4	S4	C	China east to Japan, Kamchatka to Southcentral AK.	E edge of range in insular and coastal PWS.	Meadows, mountain slopes, dry rocky heath.	1,3,4	1,2,3	3,4,5
<i>Delphinium brachycentrum</i>	G4G5	S4	C	E Asia, east to northern AK to northern Yukon, Alaska Range with disj. populations south.	S edge of the range in Chugach.	Well-drained tundra slopes.	4,6	3,4,5	2,3
<i>Dianthus repens</i>	G5	S4	C	N Asia E to northwestern AK. Disj. population on Kenai Peninsula.	S and E edge of the range on Kenai Peninsula, and disj. from northwest AK.	Sandy, gravelly, and rocky places, talus slopes, herbaceous meadows.	6	5	2,3

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Table 3-40: Vascular plants with potential viability concerns known or suspected to occur on the Chugach National Forest.

PLANT NAME	G RANK	S RANK	S/C	RANGEWIDE DISTRIBUTION	CHUGACH NF DISTRIBUTION	HABITAT	BIO CLIM	COV TYPE	LAND TYPE
<i>Douglasia alaskana</i>	G2G3	S2S3	C	Endemic to S AK & SW YT, Atlin L. BC.	S coastal range edge on Kenai Peninsula.; Seward, and Crescent L.	Rocky or sandy sites in subalpine and alpine.	4,5,6	5	2
<i>Draba kananaskis</i>	G1Q	S1	S	Kenai Peninsula, disj. E to Alberta. Regional endemic.	W edge of range on N Kenai Peninsula.	Dry alpine, rocky ledges and slopes.	4,5,6	5	2
<i>Eleocharis kamschatrica</i>	G4	S2	C	East Asia, east to AK, to western BC, scattered populations to eastern North America.	Disj. population on north Kenai Peninsula and Anchorage area.	Marshes, wet meadows, bog margins. In lowlands, brackish water, upper beaches.	1,3,6	1,2,3, 4	3,4,5, 6
<i>Eriophorum viridicarinatum</i>	G5	S2	C	Subarctic North America, south to NY, CO, MI, ID. Rare in YT.	NW edge of the range on Kenai Pen and Knik Arm area.	Rich bogs and meadows.	1,2,3, 4,6	1,2,3, 4	3,4,5
<i>Geum aleppicum</i> var. <i>strictum</i>	G5T5	S1S2	C	Across boreal North America, S to CA.	W edge of the range on Kenai near Hope, also known from Valdez area.	Meadows and thickets. Grassy clearings.	1,3,4, 6	1,2,3, 4	3,4,5
<i>Isoetes truncata</i>	G1G2 Q	S1	S	Known from Kodiak and Vancouver Islands, with a disj. population at Pyramid Lake, Alberta.	Suspected to occur on the Chugach.	Immersed in shallow fresh water pools or ponds.	1,2,3, 4	1,2,3, 4	3,4,5, 6
<i>Isoetes occidentalis</i>	G4G5	S1S2	C	W Aleutians, disj., E to base of AK Peninsula, disj. E to southeast AK, NW Cordillera & Sierras.	Suspected to occur on the Chugach.	Immersed in shallow fresh water pools or ponds.	1,2,3, 4	1,2,3, 4	3,4,5, 6
<i>Ligusticum calderi</i>	G3	S1	S	Kodiak I, disj. E to S southeast AK, QCI, Vancouver I.	N edge of the range at Kodiak I. Suspected to occur in the Chugach.	Alpine and subalpine meadows.	2,4,5	3,4,5	2,3
<i>Lonicera involucreata</i>	G4G5	S2	C	Widespread across northern NA, Pacific Coast, Cordillera.	W edge of range in PWS, and disj. population on Kayak Island.	Beach meadow ecotones, forest edges.	1,3	1,3,4	3,5
<i>Maianthemum stellatum</i>	G5	S2	C	Chugach Mts., Kenai, E to Yukon and boreal North America.	W edge of range on the Kenai Peninsula.	Meadows, well drained dryer areas, open forests, lakeshores.	1,3,4, 6	1,2,3	3,4,5
<i>Oenanthe sarmentosa</i>	G4G5	S3	C	Eastern Chugach, S to southeastern AK along coast to S CA. E to ID.	W edge of range Kayak Island.	Marshes, sluggish water, wet grassy herbaceous areas.	1,2,3, 4	1,2,3, 4	3,4,5
<i>Osmorhiza depauperata</i>	G5	S2S3	C	Chugach E across North America.	W edge of range on Kenai Peninsula.	Deciduous forests, on floodplains.	1,3,	1,4	3,4,5

Environment and Effects 3

Table 3-40: Vascular plants with potential viability concerns known or suspected to occur on the Chugach National Forest.

PLANT NAME	G RANK	S RANK	S/C	RANGEWIDE DISTRIBUTION	CHUGACH NF DISTRIBUTION	HABITAT	BIO CLIM	COV TYPE	LAND TYPE
<i>Papaver alboroseum</i>	G3G4	S3	S	From Kamchatka and northern Kuril Islands, disj to Cook Inlet, Kenai Peninsula disj. to N British Columbia and S Yukon.	Kenai Peninsula, Portage area, Chugach Mts.	Open areas, recently deglaciated areas, rock outcrops, sand, gravel, and on well-drained soils.	3,6	1,2,5, 6	2,3,4, 6
<i>Papaver radiculatum</i> ssp. <i>alaskanum</i>	G5T4	S3S4	C	Aleutians, E to Bering Sea Islands, Alaska Peninsula, Kodiak I. to Kenai Peninsula.	E and SE edge of range on Kenai Peninsula.	Sandy, gravelly soil, rocky tundra.	2,4,6, 7	3,4,5	2,3
<i>Pedicularis macrodonta</i>	G4Q	S3	C	Boreal North America.	SW edge of the range on Kenai Peninsula.	Swamps, muskegs, wet meadows.	1,2,3, 4,6,7	1,2,3, 4	3,4,5
<i>Piperia unalascensis</i>	G5	S2	C	Aleutians, E & S along coast, BC, WA, ID, Northern Rocky Mts., & montane CA.	Disj. populations in Chugach.	Meadows, bog edges.	1,2,3, 4	1,2,3, 4	3,4,5
<i>Platanthera hyperborea</i> var. <i>viridiflora</i>	G5T4 T5	S4	C	Japan-Aleutians, E to Kenai Peninsula.	E edge of range on Kenai Peninsula	Wet meadows, herbaceous back beaches, wet seepage slopes.	1,2,3, 4	1,2,3, 4	3,4,5
<i>Poa douglasii</i> ssp. <i>macrantha</i>	G5T5	S1	C	Coastal, PWS to California. Northwest coast endemic.	NW edge of range in near Cordova. Suspected in appropriate habitat to the W.	Sandy maritime beaches and meadows. Herbaceous meadows in sandy soil.	1,2	1,3,4, 6	3,5
<i>Potentilla diversifolia</i>	G5	S3S4	C	Cordilleran.	W end of range on Kenai.	Alpine meadows and slopes, solifluction soil. Open rocky slopes.	3,4,5, 6	2,3,5, 6	2,3,4
<i>Potentilla drummondii</i>	G5	S1	C	PWS SE to BC, ALB, WA, OR.	NW range edge in Chugach.	Alpine-subalpine meadows.	6	1	3
<i>Primula eximia</i>	G5	S4	C	Chukotka to Seward Peninsula, Aleutians E to Alaska Range to Canada, SE to southeastern AK.	Populations in Chugach (Cordova area, Montague I) disj. from remainder of range.	Alpine meadows, late snowbeds.	2,4,5, 6	3,4,5	2,3
<i>Puccinellia glabra</i>	G2Q	S2	S	Southcentral coastal Alaska.	Cook Inlet, Kenai Peninsula Endemic.	Maritime beaches, coastal wetlands.	3	1,6	3
<i>Puccinellia triflora</i>	G3Q	S3	C	Southcentral coastal Alaska.	Cook Inlet, Kenai Peninsula Endemic.	Maritime beaches, coastal wetlands.	3	1,6	3
<i>Ranunculus cooleyae</i>	G4	S4	C	SE along Coast Range to NW WA.	NW range edge on Kenai Peninsula and insular PWS. Pacific northwest endemic.	Alpine and subalpine meadows.	2,3,4, 6,7	4,5	2

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Table 3-40: Vascular plants with potential viability concerns known or suspected to occur on the Chugach National Forest.

PLANT NAME	G RANK	S RANK	S/C	RANGEWIDE DISTRIBUTION	CHUGACH NF DISTRIBUTION	HABITAT	BIO CLIM	COV TYPE	LAND TYPE
<i>Romanzoffia unalaschcensis</i>	G3	S3	S	Eastern Aleutian Islands E to Kodiak I., through PWS, disj. to Southeast AK. Endemic to Alaska.	Insular and coastal PWS.	Cracks in rock outcrops, along stream banks, beach terraces, open rocky areas and on grassy, mossy rock cliffs along shores, "bird rocks" maritime sea cliffs.	1,3	1,3,4	3,5
<i>Salix hookeriana</i>	G5	S2	C	Southcentral AK along coast to CA.	W edge of the range in eastern PWS.	Stabilized sand dunes, pond edges.	1,3	1,2,3,4	3,4,5
<i>Salix setchelliana</i>	G3G4	S3	C	Alaska Range, E to Coast Range in Yukon, Wrangell-St. Elias, Yakutat, S to Chugach. Regional Endemic.	SW edge of range in Chugach Mts. Suspected in Chugach Forest along large valleys and rivers.	Pioneer on moist to mesic, sandy to gravelly sites along glacial rivers and on glacial moraines in the montane zone.	1,4,6,7	2,3,5,6	2,3,4
<i>Saxifraga adscendens</i> ssp. <i>oregonensis</i>	G5T4 T5	S2S3	C	Central Alaska, E down Coast Range & Rocky Mts. to WA, ID, WY, CO.	Kenai Peninsula near W edge of range. W edge Lake Clark area.	Rocky crevices in mountains, moist gravelly rocky areas, alpine meadows.	4,5,6,7,8	5	2,3
<i>Scirpus rufus</i>	G5	S1	C	Disj. populations, eastern boreal NA, N Europe, central Asia. Wide disj. in Cook Inlet.	Disj. population from Matanuska Valley in upper Cook Inlet, suspected on shores of Turnagain Arm.	Saline soil, maritime beaches.	1,3,6	1,4,6	3,5,6
<i>Selaginella sibirica</i>	G5	S4S5	C	Amphi-Beringian, east to western MT.	S edge of the range in Chugach. Disj. population in Chugach.	Open grassy tundra, dry alpine, dry exposed rocks and ledges, rocky slopes.	4,5,6	4,5	2,3
<i>Senecio pauciflorus</i>	G5	S4S5	C	NA, south along Cordillera to CA.	SW edge of the range in Chugach.	Alpine meadows, lakeshores.	4,5,6	1,2,3,4	2,3
<i>Stellaria alaskana</i>	G3	S3	C	Southcentral Alaska & SW Yukon. Endemic.	Suspected to occur on Chugach.	Alpine tundra and scree slopes.	4,5,8	5	2
<i>Stellaria ruscifolia</i> ssp. <i>aleutica</i>	G4T2 T3	S2S3	S	Eastern Aleutians east across southern coastal Alaska to N southeast AK, Disj. population on Seward Peninsula.	Suspected to occur on Chugach.	Open gravelly sites, and along creeks in the mountains. and in lowlands in same habitat.	1,3,4,5	1,2,3,4,5	2,3,4,5
<i>Taraxacum carneocoloratum</i>	G3Q	S3	C	Endemic to Southcentral Alaska.	S edge of the range on Kenai and in Chugach Mts.	Alpine talus and scree slopes.	4,5,6,7	3,5	2,3
<i>Thlaspi arcticum</i>	G3	S3	C	NE Asia, northern Alaska, S to central & Southeast AK. S Yukon, Victoria Island.	S edge of range in Chugach and Kenai Mts.	Alpine, gravels, talus, rock outcrops.	4,5,6	5	2,3

Table 3-40: Vascular plants with potential viability concerns known or suspected to occur on the Chugach National Forest.

PLANT NAME	G RANK	S RANK	S/C	RANGEWIDE DISTRIBUTION	CHUGACH NF DISTRIBUTION	HABITAT	BIO CLIM	COV TYPE	LAND TYPE
<i>Veronica wormskioidii</i> var. <i>stelleri</i>	G4G5 Q	S4	C	Kamchatka, Kurils, disj., Japan, Aleutians, disj. to Kenai, disj. to Juneau area.	E edge of main range on Kenai Peninsula.	Meadows, mountain slopes.	3,4,5	3,4,5	2,3
<i>Viola selkirkii</i>	G5?	S3	C	Circumpolar, boreal with large gaps in distribution.	Disj. populations in Chugach Mts., northern PWS, Valdez area.	Subalpine meadows, open forest, mountain slopes, steep rocky areas.	1,3,4	1,2,3, 4	3,4,5
<i>Viola sempervirens</i>	G5	S1	C	Chugach, disj. to southeast AK, BC, WA, OR.	W range edge in insular PWS, disj.	Alpine meadows.	4	3	2

Global Rankings (G RANK)

- G1: Critically imperiled globally.
G2: Imperiled globally.
G3: Either very rare and local throughout its range or found locally in a restricted range.
G4: Apparently secure globally.
G5: Demonstrably secure globally.
GH: Species based on historical collections, possibly extinct.
G#Q: Taxonomically questionable.
G#T#: Global rank of species and global rank of the described variety or subspecies of the species.
G#G#: Global rank of species uncertain, best described as a range between the two ranks.
- State Rankings (S RANK)**
- S1: Critically imperiled in the state because of extreme rarity or some factor(s) making it especially vulnerable to extirpation from the state.
S2: Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state.
S3: Rare or uncommon in the state.
S4: Apparently secure in the state, with many occurrences.
S5: Demonstrably secure in the state, with many occurrences.
SH: Species based on historical collections, possibly extinct.
SR#: Reported from the state, but not yet verified.
SP: Occurring nearby the state or province; not yet reported in the state, but probably will be encountered with further inventory.
S#S#: State rank uncertain, best described as a range between two ranks.

Sensitive/Species Of Concern

- S Forest Service sensitive designation.
C Potential viability concern per NFMA

Distributions

- Disj Disjunct population
PWS Prince William Sound
QCI Queen Charlotte Islands
NA North America
NWC Pacific Northwest Coast

Environmental Consequences

Plants of Conservation Concern, including Sensitive Plants

The purpose of this analysis is to evaluate how activities associated with Plan alternatives may affect the viability and distribution of plants with potential conservation concerns. Table 3-41 lists these plants along with reasons for conservation concern. The Affected Environment section discusses how plants were selected for this analysis.

Table 3-41: Plants of conservation concern, and reason for concern.

PLANT NAME	REASON FOR CONSERVATION CONCERN
<i>Adiantum aleuticum</i>	Rare in Chugach, disjunct populations, edge of range in Chugach.
<i>Agrostis thurberiana</i>	Rare in Alaska, disjunct population, edge of range in Chugach.
<i>Anemone multifida</i> var. <i>saxicola</i>	Edge of range in Chugach.
<i>Aphragmus eschscholtzianus</i>	Sensitive species, rare, regional endemic.
<i>Arnica diversifolia</i>	Rare in Alaska, edge of range in Chugach.
<i>Arnica lessingii</i> ssp. <i>norbergii</i>	Sensitive species, rare, regional endemic.
<i>Artemisia tilesii</i> var. <i>unalaschcensis</i>	Rare, edge of range in Chugach.
<i>Botrychium ascendens</i>	Rare.
<i>Botrychium virginianum</i>	Rare in Alaska, disjunct population, edge of range in Chugach.
<i>Botrychium new 2x</i>	Unnamed species, rare.
<i>Botrychium new 4x</i>	Unnamed species, rare.
<i>Carex athrostachya</i>	Rare in Alaska, disjunct population.
<i>Carex lenticularis</i> var. <i>dolia</i>	Sensitive species, propose de-listing as sensitive.
<i>Carex phaeocephala</i>	Rare in Alaska, edge of range near Chugach.
<i>Carex preslii</i>	Rare in Alaska.
<i>Carex ramenskii</i>	Edge of range in Chugach.
<i>Carex stipitata</i>	Rare in Alaska, disjunct population.
<i>Castilleja parviflora</i>	Edge of range in Chugach.
<i>Coptis aspleniifolia</i>	Edge of range in Chugach.
<i>Crataegus douglasii</i> var. <i>douglasii</i>	Rare in Alaska, disjunct population, edge of range in Chugach.
<i>Dactylorhiza aristata</i>	Edge of range in Chugach.
<i>Delphinium brachycentrum</i>	Edge of range in Chugach.
<i>Dianthus repens</i>	Disjunct population, edge of range in Chugach.
<i>Douglasia alaskana</i>	Rare, disjunct population, edge of range in Chugach.
<i>Draba kananaskis</i>	Sensitive species, rare, disjunct population, edge of range in Chugach.
<i>Eleocharis kamtschatica</i>	Rare in Alaska, disjunct population.
<i>Eriophorum viridi-carinatum</i>	Rare in Alaska, edge of range in Chugach.
<i>Geum aleppicum</i> var. <i>strictum</i>	Rare, edge of range in Chugach.
<i>Isoetes truncata</i>	Sensitive species, rare.
<i>Isoetes occidentalis</i>	Rare in Alaska, suspected disjunct population.
<i>Ligusticum calderi</i>	Sensitive species, rare, edge of range suspected in Chugach.
<i>Lonicera involucrata</i>	Rare in Alaska, disjunct population, edge of range in Chugach.
<i>Maianthemum stellatum</i>	Rare in Alaska, disjunct population, edge of range in Chugach.
<i>Oenanthe sarmentosa</i>	Edge of range in Chugach.
<i>Osmorhiza depauperata</i>	Rare in Alaska, edge of range in Chugach.
<i>Papaver alboroseum</i>	Sensitive species, rare in Alaska, edge of range suspected in Chugach.
<i>Papaver radicum</i> ssp. <i>alaskanum</i>	Edge of range in Chugach.
<i>Pedicularis macrodonta</i>	Rare in Alaska, edge of range in Chugach.
<i>Piperia unalaschensis</i>	Rare in Alaska, disjunct populations.
<i>Platanthera hyperborea</i> var. <i>viridiflora</i>	Edge of range in Chugach.
<i>Poa douglasii</i> ssp. <i>macrantha</i>	Rare in Alaska, edge of range in Chugach.
<i>Potentilla diversifolia</i>	Edge of range in Chugach.
<i>Potentilla drummondii</i>	Rare in Alaska, edge of range in Chugach.
<i>Primula eximia</i>	Disjunct populations.
<i>Puccinellia glabra</i>	Sensitive species, rare, endemic.

Table 3-41: Plants of conservation concern, and reason for concern.

PLANT NAME	REASON FOR CONSERVATION CONCERN
<i>Puccinellia triflora</i>	Rare, endemic.
<i>Ranunculus cooleyae</i>	Edge of range in Chugach.
<i>Romanzoffia unalaschcensis</i>	Sensitive species, rare, regional endemic.
<i>Salix hookeriana</i>	Rare in Alaska, edge of range in Chugach.
<i>Salix setchelliana</i>	Rare in Alaska, edge of range in Chugach.
<i>Saxifraga adscendens</i> ssp. <i>oregonensis</i>	Rare in Alaska, edge of range near Chugach.
<i>Scirpus rufus</i>	Rare in Alaska, edge of range near Chugach.
<i>Selaginella sibirica</i>	Disjunct populations, edge of range in Chugach.
<i>Senecio pauciflorus</i>	Edge of range in Chugach.
<i>Stellaria alaskana</i>	Rare, disjunct populations, edge of range in Chugach.
<i>Stellaria ruscifolia</i> ssp. <i>aleutica</i>	Sensitive species, rare, regional endemic.
<i>Taraxacum carneocoloratum</i>	Rare, endemic, edge of range in Chugach.
<i>Thlaspi arcticum</i>	Rare, edge of range in Chugach.
<i>Veronica wormskjoldii</i> var. <i>stelleri</i>	Edge of range in Chugach.
<i>Viola selkirkii</i>	Rare in Alaska, disjunct populations.
<i>Viola sempervirens</i>	Rare in Alaska, disjunct populations, edge of range in Chugach.

The first step in this environmental consequences analysis was to review the general habitat information for each plant and to group the plants according to habitat. This grouping was done to facilitate analysis. Most of the plants discussed here occur in more than one habitat. A grid (Table 3-42) displays the plants and their potential habitats. The habitat information is very general, because the habitat and distribution information available for these plants in the Chugach is relatively scanty. However, even this small amount of information is helpful in organizing species into general habitats.

Table 3-42: Plants of conservation concern and their potential general habitats.

PLANT NAME	HABITAT	Sandy beach and below high tide	Upper beach meadow	Meadow	Gravelly, dry meadow	Shrubby areas	Open forest	Bog or muskeg	Riparian	Marshy areas	Lake and pond margins	Subalpine	Alpine	Rock faces	Scree/talus slopes
<i>Adiantum aleuticum</i>	Moist forested ravines, wet cliffs, rock faces, talus slopes, alpine, and subalpine meadows.			X			X		X		X	X	X	X	X
<i>Agrostis thurberiana</i>	Alpine meadows, bogs, stream margins, lake margins.							X	X		X	X	X		
<i>Anemone multifida</i> var. <i>saxicola</i>	Rocky slopes, meadows, well drained soil, gravelly areas			X	X							X			X

Table 3-42: Plants of conservation concern and their potential general habitats.

PLANT NAME	HABITAT	Sandy beach and below high tide	Upper beach meadow	Meadow	Gravelly, dry meadow	Shrubby areas	Open forest	Bog or muskeg	Riparian	Marshy areas	Lake and pond margins	Subalpine	Alpine	Rock faces	Scree/talus slopes
<i>Aphragmus eschscholtzianus</i>	Moist mossy areas, solifluction slopes, near rivulets in alpine seeps, heaths and scree slopes in the subalpine and alpine											X	X		X
<i>Arnica diversifolia</i>	Rocky gravelly areas, open areas, grassy meadows, mountains, mixed herbaceous meadows			X	X							X			
<i>Arnica lessingii</i> ssp. <i>norbergii</i>	From sea level to subalpine in well drained meadows, shrublands, dry meadows, forest openings and open forest.			X	X	X									
<i>Artemisia tilesii</i> var. <i>unalaschcensis</i>	Well-drained areas, sandy soil, alpine, lowlands.				X	X						X	X		
<i>Botrychium ascendens</i>	Beach meadows sandy areas. Mesic to dry meadows in the alpine.	X	X		X										
<i>Botrychium virginianum</i>	Shrubby grassy areas, thickets, upper beach meadows.		X	X		X									
<i>Botrychium</i> sp. new 2x	Beach meadows sandy areas, open turf or gravelly slopes, shores or meadows.	X	X		X										
<i>Botrychium</i> sp. new 4x	Beach meadows sandy areas, open turf or gravelly slopes, shores or meadows.	X	X		X										
<i>Carex athrostachya</i>	Wet meadows, lowlands to moderate elevations.		X	X								X			

Table 3-42: Plants of conservation concern and their potential general habitats.

PLANT NAME	HABITAT	Sandy beach and below high tide	Upper beach meadow	Meadow	Gravelly, dry meadow	Shrubby areas	Open forest	Bog or muskeg	Riparian	Marshy areas	Lake and pond margins	Subalpine	Alpine	Rock faces	Scree/talus slopes
<i>Carex lenticularis</i> var. <i>dolia</i>	Wet meadows, along lakeshores and snowbeds, generally at high elevations, subalpine, alpine.										X	X	X		
<i>Carex phaeocephala</i>	Wet meadows, rocky alpine slopes.			X								X	X		
<i>Carex preslii</i>	Meadows.			X											
<i>Carex ramenskii</i>	Coastal salt marsh, brackish water, beaches at high tide.	X	X												
<i>Carex stipitata</i>	Swamps and meadows, pond edges, wet low ground.			X						X	X				
<i>Castilleja parviflora</i>	Alpine and subalpine meadows.											X	X		
<i>Coptis asplenifolia</i>	Bog edges, mixed conifer forests, open forests.						X	X							
<i>Crataegus douglasii</i> var. <i>douglasii</i>	Forest edge.		X												
<i>Dactylorhiza aristata</i>	Meadows, mountain slopes, dry rocky heath.		X	X								X			
<i>Delphinium brachycentrum</i>	Well-drained tundra slopes.											X	X		
<i>Dianthus repens</i>	Sandy, gravelly, and rocky places, talus slopes, herbaceous meadows.			X	X							X			X
<i>Douglasia alaskana</i>	Rocky or sandy sites in subalpine and alpine.											X	X		X
<i>Draba kananaskis</i>	Dry alpine, rocky ledges and slopes.												X	X	X
<i>Eleocharis kamtschatica</i>	Marshes, wet meadows, bog margins. In lowlands, brackish water, upper beaches.		X	X				X		X					

Table 3-42: Plants of conservation concern and their potential general habitats.

PLANT NAME	HABITAT	Sandy beach and below high tide	Upper beach meadow	Meadow	Gravelly, dry meadow	Shrubby areas	Open forest	Bog or muskeg	Riparian	Marshy areas	Lake and pond margins	Subalpine	Alpine	Rock faces	Scree/talus slopes
<i>Eriophorum viridicarinatum</i>	Rich bogs and meadows.		X					X							
<i>Geum aleppicum</i> var. <i>strictum</i>	Meadows and thickets. Grassy clearings.			X		X									
<i>Isoetes truncata</i>	Immersed in shallow fresh water pools or ponds.										X				
<i>Isoetes occidentalis</i>	Immersed in shallow fresh water pools or ponds.										X				
<i>Ligusticum calderi</i>	Alpine and subalpine meadows.											X			
<i>Lonicera involucrata</i>	Beach meadow ecotones, forest edges.		X				X								
<i>Maianthemum stellatum</i>	Meadows, well drained dryer areas, open forests, lakeshores.			X	X		X				X				
<i>Oenanthe sarmentosa</i>	Marshes, sluggish water, wet grassy herbaceous areas.			X						X	X				
<i>Osmorhiza depauperata</i>	Deciduous forests, on floodplains.		X				X		X						
<i>Papaver alboroseum</i>	Open areas, recently deglaciated areas, rock outcrops, sand, gravel, and on well-drained soils.				X				X						
<i>Papaver radicum</i> ssp. <i>alaskanum</i>	Sandy, gravelly soil, rocky tundra.				X							X	X		
<i>Pedicularis macrodonta</i>	Swamps, muskegs, wet meadows.			X				X		X					
<i>Piperia unalascensis</i>	Meadows, bog edges.		X	X				X							
<i>Platanthera hyperborea</i> var. <i>viridiflora</i>	Wet meadows, herbaceous back beaches, wet seepage slopes.		X	X											

Table 3-42: Plants of conservation concern and their potential general habitats.

PLANT NAME	HABITAT	Sandy beach and below high tide	Upper beach meadow	Meadow	Gravelly, dry meadow	Shrubby areas	Open forest	Bog or muskeg	Riparian	Marshy areas	Lake and pond margins	Subalpine	Alpine	Rock faces	Scree/talus slopes
<i>Poa douglasii</i> ssp. <i>macrantha</i>	Sandy maritime beaches and meadows. Herbaceous meadows in sandy soil.	X	X												
<i>Potentilla diversifolia</i>	Alpine meadows and slopes, solifluction soil. Open rocky slopes.											X	X		
<i>Potentilla drummondii</i>	Alpine-subalpine meadows											X			
<i>Primula eximia</i>	Alpine meadows. late snowbeds.												X		
<i>Puccinellia glabra</i>	Maritime beaches, coastal wetlands.	X													
<i>Puccinellia triflora</i>	Maritime beaches, coastal wetlands.	X													
<i>Ranunculus cooleyae</i>	Alpine and subalpine meadows.											X	X		
<i>Romanzoffia unalaschcensis</i>	Cracks in rock outcrops, along stream banks, beach terraces, open rocky areas and on grassy, mossy rock cliffs along shores, "bird rocks" maritime sea cliffs.		X											X	
<i>Salix hookeriana</i>	Stabilized sand dunes, pond edges.		X								X				
<i>Salix setchelliana</i>	Pioneer on moist to mesic, sandy to gravelly sites along glacial rivers and on glacial moraines in the montane zone.			X	X				X			X			
<i>Saxifraga adscendens</i> ssp. <i>oregonensis</i>	Rocky crevices in mountains, moist gravelly rocky areas, alpine meadows.											X	X		
<i>Scirpus rufus</i>	Saline soil, maritime beaches.	X													

Table 3-42: Plants of conservation concern and their potential general habitats.

PLANT NAME	HABITAT	Sandy beach and below high tide	Upper beach meadow	Meadow	Gravelly, dry meadow	Shrubby areas	Open forest	Bog or muskeg	Riparian	Marshy areas	Lake and pond margins	Subalpine	Alpine	Rock faces	Scree/talus slopes
<i>Selaginella sibirica</i>	Open grassy tundra, dry alpine, dry exposed rocks and ledges, rocky slopes.											X	X		
<i>Senecio pauciflorus</i>	Alpine meadows, lakeshores.										X	X	X		
<i>Stellaria alaskana</i>	Alpine tundra and scree slopes.												X		X
<i>Stellaria ruscifolia</i> ssp. <i>aleutica</i>	Open gravelly sites, and along creeks in the mountains. and in lowlands in same habitat.				X				X			X			
<i>Taraxacum carneocoloratum</i>	Alpine talus and scree slopes.												X		X
<i>Thlaspi arcticum</i>	Alpine, gravels, talus, rock outcrops.												X	X	X
<i>Veronica wormskjoldii</i> var. <i>stelleri</i>	Meadows, mountain slopes.			X								X			
<i>Viola selkirkii</i>	Subalpine meadows, open forest, mountain slopes, steep rocky areas.						X					X		X	
<i>Viola sempervirens</i>	Alpine meadows.											X	X		

A table was also developed to show which of the elements (risk factors) from the Management Prescription Activity Matrix may affect the various general habitats and the plants associated with those habitats. These risk factors are displayed in the grid shown in Table 3-43.

Table 3-43: Potential risk factors to plant species of conservation concern by habitat.

General habitats														
Potential Risks to Plants (from Activity Matrix)	Sandy beach and below high tide	Upper beach meadow	Meadow	Gravelly, dry meadow	Shrubby areas	Open forest	Bog or muskeg	Riparian	Marshy areas	Lake and pond margins	Subalpine	Alpine	Rock faces	Scree / talus slopes
FS vegetation management		X	X	X	X	X								
FS fish habitat projects								X	X	X				
Pest management						X		X						
Invasion by exotic plants	X	X	X	X	X	X		X		X				
Prescribed fire				X	X	X								
Timber harvest						X		X		X				
Commercial special forest products	X	X	X	X	X	X	X	X	X	X	X			
Personal use special forest products	X	X	X	X	X	X	X	X	X	X	X	X	X	
Minerals activities				X	X	X		X		X	X	X	X	X
Recreational gold panning								X		X	X	X	X	X
OHV designated routes, summer	X			X	X	X	X	X		X	X	X		
OHV other purposes	X	X	X	X	X	X	X	X	X	X	X	X		X
Nonmotorized recreation use, hiking camping	X	X	X	X	X	X	X	X		X	X	X	X	X
Day use facilities		X		X				X		X				
FS recreational cabins		X	X	X	X	X	X			X				
Campgrounds		X	X	X	X	X		X		X	X			
Hardened dispersed camping	X	X	X	X	X	X		X		X	X	X		
Marine transfer facilities	X	X												
Boat docks and ramps	X	X							X	X				
Mode changes: parking lots at trailheads, ferry terminals, etc.	X	X	X	X	X	X		X		X	X			
New roads	X	X	X	X	X	X	X	X	X	X	X			
New trails		X	X	X	X	X	X	X	X	X	X	X		X
Trail reconstruction		X	X	X	X	X	X	X	X	X	X	X		X
Electronic sites											X	X		
SUP storage areas (fisheries)	X	X	X	X									X	
Utility systems	X	X	X		X	X	X	X	X	X	X		X	X
SUP helicopter landings summer	X	X	X	X	X		X	X		X	X	X		
SUP fixed wing flightseeing landings	X	X		X	X			X		X				
SUP guided hiking and climbing	X	X	X	X	X	X	X	X		X	X	X	X	X
SUP destination lodges		X		X	X	X		X		X	X			
Non-FS SUP cabins		X	X	X	X	X		X		X	X			
SUP recreation equipment cache		X	X	X	X	X				X	X			

Using this information, plants and risk were sorted by general habitat (Table 3-44). This table provides a picture of how many plants of concern occur in the different habitats, and shows which of the risk factors might affect the plants or their habitats.

Table 3-44: General habitats and associated plants of conservation concern and their potential risks.

SANDY BEACH & BELOW HIGH TIDE	
Plants	Risks
<i>Botrychium ascendens</i>	Boat docks and ramps
<i>Botrychium sp. new 2x</i>	Commercial special forest products
<i>Botrychium sp. new 4x</i>	Hardened dispersed camping
<i>Carex ramenskii</i>	Invasion by exotic plants
<i>Poa douglasii ssp. macrantha</i>	Marine transfer facilities
<i>Puccinellia glabra</i>	Mode changes: parking lots at trailheads, ferry terminals, etc.
<i>Puccinellia triflora</i>	New roads
<i>Scirpus rufus</i>	Nonmotorized recreation use, hiking camping
	OHV designated routes, summer
	OHV other purposes
	Personal use special forest products
	SUP fixed-wing flightseeing landings
	SUP guided hiking and climbing
	SUP helicopter landings summer
	SUP storage areas (fisheries)
	Utility systems
UPPER BEACH MEADOW	
Plants	Risks
<i>Botrychium ascendens</i>	Boat docks and ramps
<i>Botrychium sp new 2x</i>	Campgrounds
<i>Botrychium sp new 4x</i>	Commercial special forest products
<i>Botrychium virginianum</i>	Day use facilities
<i>Carex athrostachya</i>	FS recreational cabins
<i>Carex ramenskii</i>	FS vegetation management
<i>Crataegus douglasii var. douglasii</i>	Hardened dispersed camping
<i>Dactylorhiza aristata</i>	Invasion by exotic plants
<i>Eleocharis kamtschatica</i>	Marine transfer facilities
<i>Eriophorum viridi-carinatum</i>	Mode changes: parking lots at trailheads, ferry terminals, etc.
<i>Lonicera involucrata</i>	New roads
<i>Osmorhiza depauperata</i>	New trails
<i>Piperia unalascensis</i>	Non-FS SUP cabins
<i>Platanthera hyperborea var. viridiflora</i>	Nonmotorized recreation use, hiking camping
<i>Poa douglasii ssp. macrantha</i>	OHV other purposes
<i>Romanzoffia unalaschcensis</i>	Personal use special forest products
<i>Salix hookeriana</i>	SUP destination lodges
	SUP fixed-wing flightseeing landings
	SUP guided hiking and climbing
	SUP helicopter landings summer
	SUP rec. equipment cache
	SUP storage areas (fisheries)
	Trail reconstruction
	Utility systems

Table 3-44: General habitats and associated plants of conservation concern and their potential risks.

MEADOW	
Plants	Risks
<i>Adiantum aleuticum</i>	Campgrounds
<i>Anemone multifida</i> var. <i>saxicola</i>	Commercial special forest products
<i>Arnica diversifolia</i>	FS recreational cabins
<i>Arnica lessingii</i> ssp. <i>norbergii</i>	FS vegetation management
<i>Botrychium virginianum</i>	Hardened dispersed camping
<i>Carex athrostachya</i>	Invasion by exotic plants
<i>Carex phaeocephala</i>	Mode changes: parking lots at trailheads, ferry terminals, etc.
<i>Carex preslii</i>	
<i>Carex stipitata</i>	New roads
<i>Dactylorhiza aristata</i>	New trails
<i>Dianthus repens</i>	Non-FS SUP cabins
<i>Eleocharis kamtschatica</i>	Nonmotorized recreation use, hiking camping
<i>Geum aleppicum</i> var. <i>strictum</i>	OHV other purposes
<i>Maianthemum stellatum</i>	Personal use special forest products
<i>Oenanthe sarmentosa</i>	SUP guided hiking and climbing
<i>Pedicularis macrodonta</i>	SUP helicopter landings summer
<i>Piperia unalasensis</i>	SUP rec. equipment cache
<i>Platanthera hyperborea</i> var. <i>viridiflora</i>	SUP storage areas (fisheries)
<i>Salix setchelliana</i>	Trail reconstruction
<i>Veronica wormskjoldii</i> var. <i>stelleri</i>	Utility systems
GRAVELLY, DRY MEADOW	
Plants	Risks
<i>Anemone multifida</i> var. <i>saxicola</i>	Campgrounds
<i>Arnica diversifolia</i>	Commercial special forest products
<i>Arnica lessingii</i> ssp. <i>norbergii</i>	Day use facilities
<i>Artemisia tilesii</i> var. <i>unalaschensis</i>	FS recreational cabins
<i>Botrychium ascendens</i>	FS vegetation management
<i>Botrychium</i> sp new 2x	Hardened dispersed camping
<i>Botrychium</i> sp new 4x	Invasion by exotic plants
<i>Dianthus repens</i>	Minerals activities
<i>Maianthemum stellatum</i>	Mode changes: parking lots at trailheads, ferry terminals, etc.
<i>Papaver alboroseum</i>	
<i>Papaver radicum</i> ssp. <i>alaskanum</i>	New roads
<i>Salix setchelliana</i>	New trails
<i>Stellaria ruscifolia</i> ssp. <i>aleutica</i>	Non-FS SUP cabins
	Nonmotorized recreation use, hiking camping
	OHV designated routes, summer
	OHV other purposes
	Personal use special forest products
	Prescribed fire
	SUP destination lodges
	SUP fixed-wing flightseeing landings
	SUP guided hiking and climbing
	SUP helicopter landings summer
	SUP recreation equipment cache
	SUP storage areas (fisheries)
	Trail reconstruction

Table 3-44: General habitats and associated plants of conservation concern and their potential risks.

SHRUBBY AREAS	
Plants	Risks
<i>Arnica lessingii</i> ssp. <i>norbergii</i>	Campgrounds
<i>Artemisia tilesii</i> var. <i>unalaschcensis</i>	Commercial special forest products
<i>Botrychium virginianum</i>	FS recreational cabins
<i>Geum aleppicum</i> var. <i>strictum</i>	FS vegetation management
	Hardened dispersed camping
	Invasion by exotic plants
	Minerals activities
	Mode changes: parking lots at trailheads, ferry terminals, etc.
	New roads
	New trails
	Non-FS SUP cabins
	Nonmotorized recreation use, hiking camping
	OHV designated routes, summer
	OHV other purposes
	Personal use special forest products
	Prescribed fire
	SUP destination lodges
	SUP fixed-wing flightseeing landings
	SUP guided hiking and climbing
	SUP helicopter landings summer
	SUP rec. equipment cache
	Trail reconstruction
	Utility systems
OPEN FOREST	
Plants	Risks
<i>Adiantum aleuticum</i>	Campgrounds
<i>Coptis asplenifolia</i>	Commercial special forest products
<i>Lonicera involucrata</i>	FS recreational cabins
<i>Maianthemum stellatum</i>	FS vegetation management
<i>Osmorhiza depauperata</i>	Hardened dispersed camping
<i>Viola selkirkii</i>	Invasion by exotic plants
	Minerals activities
	Mode changes: parking lots at trailheads, ferry terminals, etc.
	New roads
	New trails
	Non-FS SUP cabins
	Nonmotorized recreation use, hiking camping
	OHV designated routes, summer
	OHV other purposes
	Personal use special forest products
	Pest management
	Prescribed fire
	SUP destination lodges
	SUP guided hiking and climbing
	SUP rec. equipment cache
	Timber harvest
	Trail reconstruction
	Utility systems

Table 3-44: General habitats and associated plants of conservation concern and their potential risks.

BOG OR MUSKEG	
Plants	Risks
<i>Coptis aspleniifolia</i>	Commercial special forest products
<i>Eleocharis kamtschatica</i>	FS recreational cabins
<i>Eriophorum viridi-carinatum</i>	New roads
<i>Pedicularis macrodonta</i>	New trails
<i>Piperia unalascensis</i>	Nonmotorized recreation use, hiking camping
	OHV designated routes, summer
	OHV other purposes
	Personal use special forest products
	SUP guided hiking and climbing
	SUP helicopter landings summer
	Trail reconstruction
	Utility systems
RIPARIAN	
Plants	Risks
<i>Adiantum aleuticum</i>	Campgrounds
<i>Agrostis thurberiana</i>	Commercial special forest products
<i>Osmorhiza depauperata</i>	Day use facilities
<i>Papaver alboroseum</i>	FS fish habitat projects
<i>Salix setchelliana</i>	FS recreational cabins
<i>Stellaria ruscifolia</i> ssp. <i>aleutica</i>	Hardened dispersed camping
	Invasion by exotic plants
	Minerals activities
	Mode changes: parking lots at trailheads, ferry terminals, etc.
	New roads
	New trails
	Non-FS SUP cabins
	Nonmotorized recreation use, hiking camping
	OHV designated routes, summer
	OHV other purposes
	Personal use special forest products
	Pest management
	Recreational gold panning
	SUP destination lodges
	SUP fixed-wing flightseeing landings
	SUP guided hiking and climbing
	SUP helicopter landings summer
	Timber harvest
	Trail reconstruction
	Utility systems

Table 3-44: General habitats and associated plants of conservation concern and their potential risks.

MARSHY AREAS	
Plants	Risks
<i>Carex stipitata</i>	Boat docks and ramps
<i>Eleocharis kamtschatica</i>	Commercial special forest products
<i>Oenanthe sarmentosa</i>	FS fish habitat projects
<i>Pedicularis macrodonta</i>	New roads
	New trails
	OHV other purposes
	Personal use special forest products
	Trail reconstruction
	Utility systems
LAKE & POND MARGINS	
Plants	Risks
<i>Adiantum aleuticum</i>	Boat docks and ramps
<i>Agrostis thurberiana</i>	Campgrounds
<i>Carex lenticularis</i> var. <i>dolia</i>	Commercial special forest products
<i>Carex stipitata</i>	Day use facilities
<i>Isoetes occidentalis</i>	FS fish habitat projects
<i>Isoetes truncata</i>	FS recreational cabins
<i>Maianthemum stellatum</i>	Hardened dispersed camping
<i>Oenanthe sarmentosa</i>	Invasion by exotic plants
<i>Salix hookeriana</i>	Minerals activities
<i>Senecio pauciflorus</i>	Mode changes: parking lots at trailheads, ferry terminals, etc.
	New roads
	New trails
	Non-FS SUP cabins
	Nonmotorized recreation use, hiking camping
	OHV designated routes, summer
	OHV other purposes
	Personal use special forest products
	Recreational gold panning
	SUP destination lodges
	SUP fixed-wing flightseeing landings
	SUP guided hiking and climbing
	SUP helicopter landings summer
	SUP rec. equipment cache
	Timber harvest
	Trail reconstruction
	Utility systems

Table 3-44: General habitats and associated plants of conservation concern and their potential risks.

SUBALPINE	
Plants	Risks
<i>Adiantum aleuticum</i>	Campgrounds
<i>Agrostis thurberiana</i>	Commercial special forest products
<i>Anemone multifida</i> var. <i>saxicola</i>	Electronic sites
<i>Aphragmus eschscholtzianus</i>	Hardened dispersed camping
<i>Arnica diversifolia</i>	Minerals activities
<i>Artemisia tilesii</i> var. <i>unalaschcensis</i>	Mode changes: parking lots at trailheads, ferry terminals, etc.
<i>Carex athrostachya</i>	New roads
<i>Carex lenticularis</i> var. <i>dolia</i>	New trails
<i>Carex phaeocephala</i>	Non-FS SUP cabins
<i>Castilleja parviflora</i>	Nonmotorized recreation use, hiking camping
<i>Dactylorhiza aristata</i>	OHV designated routes, summer
<i>Delphinium brachycentrum</i>	OHV other purposes
<i>Dianthus repens</i>	Personal use special forest products
<i>Douglasia alaskana</i>	Recreational gold panning
<i>Ligusticum calderi</i>	SUP destination lodges
<i>Papaver radicatum</i> ssp. <i>alaskanum</i>	SUP guided hiking and climbing
<i>Potentilla diversifolia</i>	SUP helicopter landings summer
<i>Potentilla drummondii</i>	SUP rec. equipment cache
<i>Ranunculus cooleyae</i>	Trail reconstruction
<i>Salix setchelliana</i>	Utility systems
<i>Saxifraga adscendens</i> ssp. <i>oregonensis</i>	
<i>Selaginella sibirica</i>	
<i>Senecio pauciflorus</i>	
<i>Stellaria ruscifolia</i> ssp. <i>aleutica</i>	
<i>Veronica wormskjoldii</i> var. <i>stelleri</i>	
<i>Viola selkirkii</i>	
<i>Viola sempervirens</i>	
ALPINE	
Plants	Risks
<i>Adiantum aleuticum</i>	Electronic sites
<i>Agrostis thurberiana</i>	Hardened dispersed camping
<i>Aphragmus eschscholtzianus</i>	Minerals activities
<i>Artemisia tilesii</i> var. <i>unalaschcensis</i>	New trails
<i>Carex lenticularis</i> var. <i>dolia</i>	Nonmotorized recreation use, hiking camping
<i>Carex phaeocephala</i>	OHV designated routes, summer
<i>Castilleja parviflora</i>	OHV other purposes
<i>Delphinium brachycentrum</i>	Personal use special forest products
<i>Douglasia alaskana</i>	Recreational gold panning
<i>Draba kananaskis</i>	SUP guided hiking and climbing
<i>Papaver radicatum</i> ssp. <i>alaskanum</i>	SUP helicopter landings summer
<i>Potentilla diversifolia</i>	Trail reconstruction
<i>Primula eximia</i>	
<i>Ranunculus cooleyae</i>	
<i>Saxifraga adscendens</i> ssp. <i>oregonensis</i>	
<i>Selaginella sibirica</i>	
<i>Senecio pauciflorus</i>	
<i>Stellaria alaskana</i>	
<i>Taraxacum carneocoloratum</i>	
<i>Thlaspi arcticum</i>	
<i>Viola sempervirens</i>	

Table 3-44: General habitats and associated plants of conservation concern and their potential risks.

ROCK FACES	
Plants	Risks
<i>Adiantum aleuticum</i>	Minerals activities
<i>Draba kananaskis</i>	Nonmotorized recreation use, hiking camping
<i>Romanzoffia unalaschcensis</i>	Personal use special forest products
<i>Thlaspi arcticum</i>	Recreational gold panning
<i>Viola selkirkii</i>	SUP guided hiking and climbing
	SUP storage areas (fisheries, beach rocks)
	Utility systems
SCREE/TALUS SLOPES	
Plants	Risks
<i>Adiantum aleuticum</i>	Minerals activities
<i>Anemone multifida</i> var. <i>saxicola</i>	New trails
<i>Aphragmus eschscholtzianus</i>	Nonmotorized recreation use, hiking camping
<i>Dianthus repens</i>	OHV other purposes
<i>Douglasia alaskana</i>	Recreational gold panning
<i>Draba kananaskis</i>	SUP guided hiking and climbing
<i>Stellaria alaskana</i>	Trail reconstruction
<i>Taraxacum carneocoloratum</i>	Utility systems
<i>Thlaspi arcticum</i>	

As shown in Table 3-44, activities associated with an array of risks could potentially result in direct as well as indirect effects to individual plants of conservation concern, populations of these plants or their general habitat. Risks remain essentially the same for each alternative because of the Forest's large size and intricate mosaic of habitats and prescriptions. However, proposed management including habitat alteration in these habitats is minimal, since such a small amount of the habitat might be directly or indirectly affected by the risks. Therefore, the consequences of the effects of these potential risks on the plants and their habitat are minimal. In addition, Laws, Regulation, Policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain plants of conservation concern and their habitat, no matter which alternative is selected. Therefore, there is a low likelihood of effects to the plants or their habitat as the result of any alternative.

On account of these factors, the likelihood of risk to the viability of the plants of conservation concern is low because habitat is of sufficient quality, similar to expected range and abundance to allow the plants to continue maintaining well-distributed reproducing populations across the Forest.

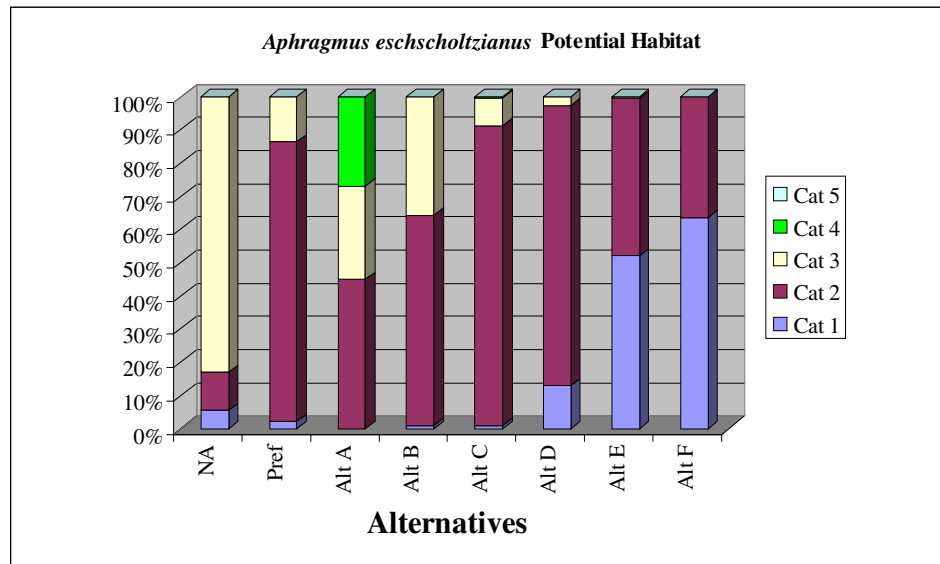
Sensitive Plant Species

The Alaska Region Sensitive Species List was first established in 1990, and a technical revision was completed in 1994 when 22 plants and Queen Charlotte goshawk were added. The list was revised in 1999 when four plants were removed from the list. There are 18 plants designated as sensitive species within the Alaska Region. Ten plants are known or suspected to occur on the Chugach National Forest. The next section discusses the effect of the

alternatives on the ten Regional sensitive plants found on the Chugach National Forest.

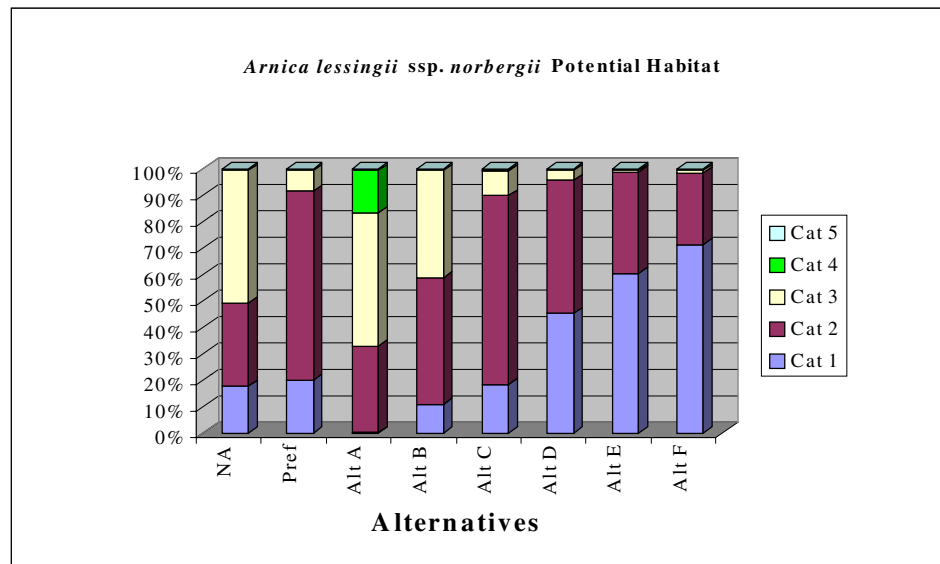
Aphragmus eschscholtzianus, (Eschscholtz's little nightmare). The potential habitats of the plant are moist mossy areas, solifluction slopes, seeps, heaths and scree slopes in subalpine and alpine areas. The *Aphragmus* or its habitat could be affected by activities relating to campgrounds, commercial special forest products, electronic sites, hardened dispersed camping, minerals activities, mode changes such as parking lots at trailheads, new roads, new trails, cabins, nonmotorized recreation use, hiking, camping, OHV designated routes, summer OHV other purposes, personal use special forest products, recreational gold panning, SUP destination lodges, guided hiking and climbing, helicopter landings summer, recreational equipment cache, trail reconstruction, or utility systems. The likelihood of these activities affecting the viability of the plant on the Forest is low because the plant occurs in generally remote alpine areas where the potential for these activities is low. The differences between the potential effects of the alternatives are displayed in the Figure 3-27. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-27: Distribution of potential *Aphragmus eschscholtzianus* habitat on the Chugach National Forest by prescription category and alternative.



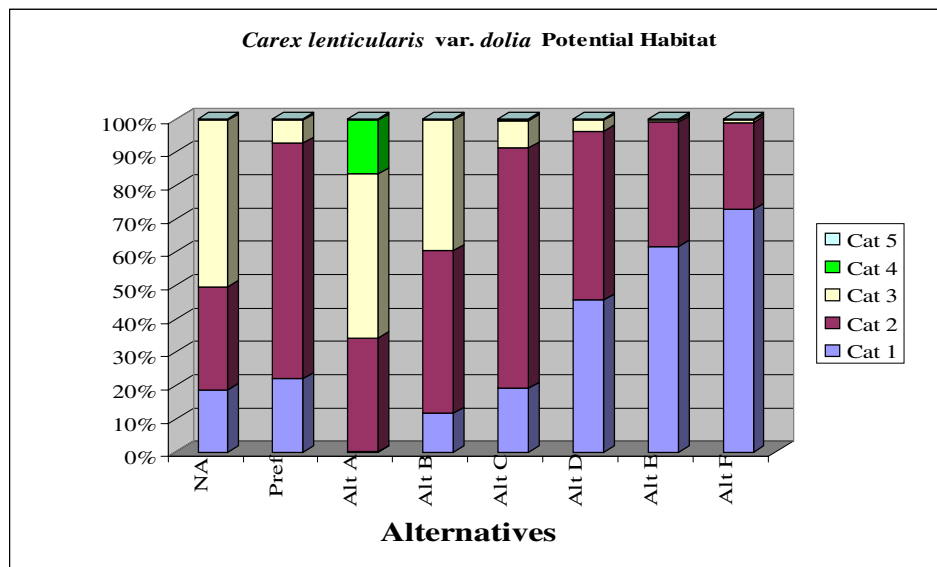
Arnica lessingii* ssp. *norbergii, (Norberg Arnica). The potential habitats of the plant are well-drained and dry meadows, shrublands forest openings and open forest from sea level to subalpine. The *Arnica* or its habitat could be affected by activities relating to campgrounds, commercial special forest products, day use facilities, recreational cabins, vegetation management, hardened dispersed camping, invasion by exotic plants, minerals activities, mode changes: parking lots at trailheads, ferry terminals, new roads, new trails, cabins, nonmotorized recreation use, hiking camping, OHV designated routes, summer, OHV other purposes, personal use special forest products, prescribed fire, destination lodges, fixed-wing flightseeing landings, guided hiking and climbing, helicopter landings summer, recreational equipment cache, storage areas (fisheries), trail reconstruction, and utility systems. The differences between the potential effects of the alternatives are displayed in Figure 3-28. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applies to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-28: Distribution of potential *Arnica lessingii* ssp. *norbergii* habitat on the Chugach National Forest by prescription category and alternative.



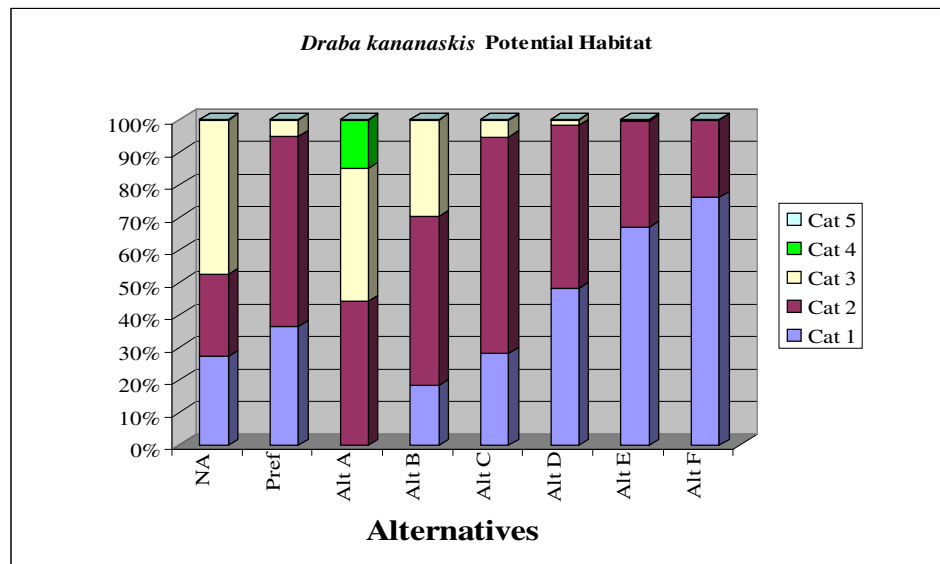
Carex lenticularis* var. *dolia, (Goose-grass Sedge). The potential habitats of the plant are pond and lake margins, wet meadows, and snowbeds in the subalpine and alpine. The *Carex* or its habitat could be affected by activities relating to boat docks and ramps, campgrounds, commercial special forest products, day use facilities, electronic sites, fish habitat projects, recreational cabins, hardened dispersed camping, invasion by exotic plants, minerals activities, mode changes: parking lots at trailheads, new roads, new trails, cabins, nonmotorized recreation use, hiking, camping, OHV designated routes, summer, OHV other purposes, personal use special forest products, recreational gold panning, destination lodges, guided hiking and climbing, helicopter landings summer, recreational equipment cache, trail reconstruction, utility systems. The likelihood of these activities affecting the viability of the plant in the Forest is low because the plant occurs in generally remote alpine areas where the potential for these activities is low. The differences between the potential effects of the alternatives are displayed in Figure 3-29. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability. Recent taxonomic treatments have added *Carex enanderi* to this taxon. Thus, the plant is more abundant than before *Carex enanderi* was subsumed by *Carex lenticularis* var. *dolia*, thus further lowering the risk to this plant.

Figure 3-29: Distribution of potential *Carex lenticularis* var. *dolia* habitat on the Chugach National Forest by prescription category and alternative.



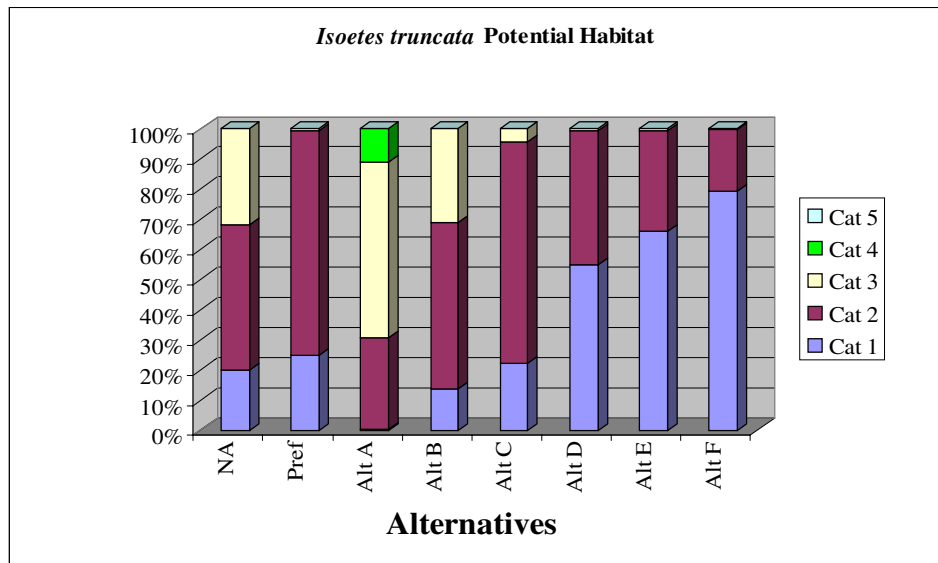
Draba kananaskis, (Tundra Whitlow-grass). The potential habitats of the plant are rocky ledges, dry areas and scree slopes in subalpine and alpine areas. The *Draba* or its habitat could be affected by activities relating to campgrounds, commercial special forest products, electronic sites, hardened dispersed camping, minerals activities, mode changes such as parking lots at trailheads, new roads, new trails, cabins, nonmotorized recreation use, hiking, camping, OHV designated routes, summer OHV other purposes, personal use special forest products, recreational gold panning, destination lodges, guided hiking and climbing, helicopter landings summer, recreational equipment cache, trail reconstruction, or utility systems. The likelihood of these activities affecting the viability of the plant on the Forest is low because the plant occurs in generally remote alpine areas where the potential for these activities is low. The differences between the potential effects of the alternatives are displayed in Figure 3-30. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-30: Distribution of potential *Draba kananaskis* habitat on the Chugach National Forest by prescription category and alternative.



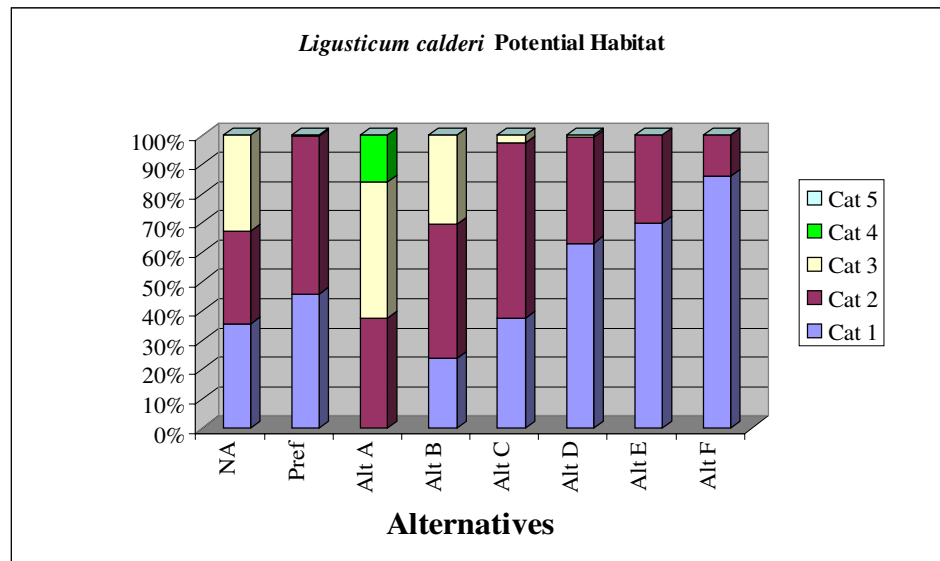
***Isoetes truncata* (*Isoetes x truncata*)**, (Truncate Quillwort). The habitat of the plant is the shallows of lakes and ponds, where it is generally immersed in freshwater. The *Isoetes* or its habitat could be affected by activities relating to boat docks and ramps, campgrounds, commercial special forest products, day use facilities, fish habitat projects, recreational cabins, hardened dispersed camping, invasion by exotic plants, minerals activities, mode changes: parking lots at trailheads, new roads, new trails, cabins, nonmotorized recreation use, hiking, camping, OHV designated routes, summer, OHV other purposes, personal use special forest products, recreational gold panning, destination lodges, guided hiking, recreational equipment cache, timber harvest, and utility systems. The differences between the potential effects of the alternatives are displayed in Figure 3-31. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-31: Distribution of potential *Isoetes truncata* habitat on the Chugach National Forest by prescription category and alternative.



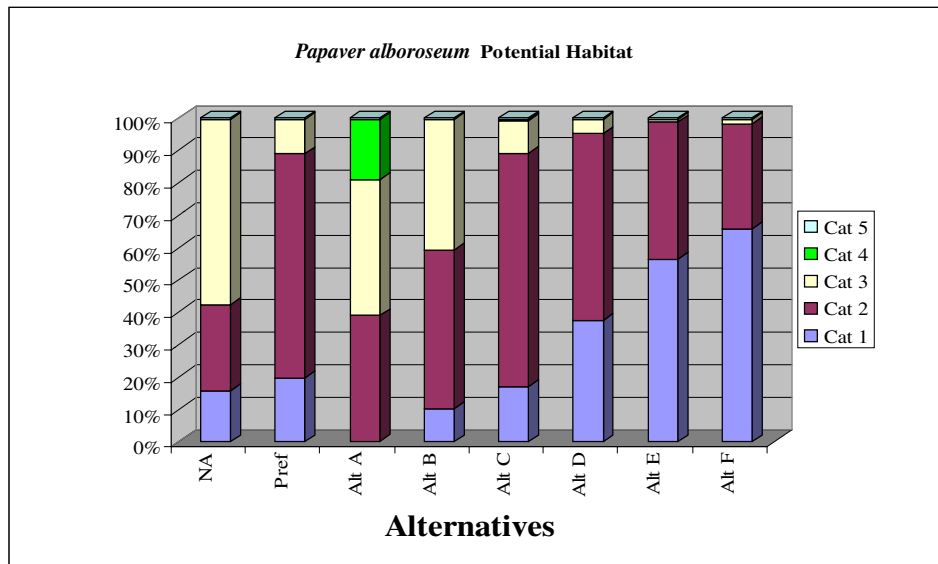
Ligusticum calderi, (Calder Lovage). The potential habitats of the plant are meadows in subalpine and alpine areas. The *Ligusticum* or its habitat could be affected by activities relating to campgrounds, commercial special forest products, electronic sites, hardened dispersed camping, minerals activities, mode changes such as parking lots at trailheads, new roads, new trails, cabins, nonmotorized recreation use, hiking, camping, OHV designated routes, summer OHV other purposes, personal use special forest products, recreational gold panning, destination lodges, guided hiking and climbing, helicopter landings summer, recreational equipment cache, trail reconstruction, or utility systems. The likelihood of these activities affecting the viability of the plant on the Forest is low because the plant occurs in generally remote subalpine and alpine areas where the potential for these activities is low. The differences between the potential effects of the alternatives are displayed in Figure 3-32. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-32: Distribution of potential *Ligusticum calderi* habitat on the Chugach National Forest by prescription category and alternative.



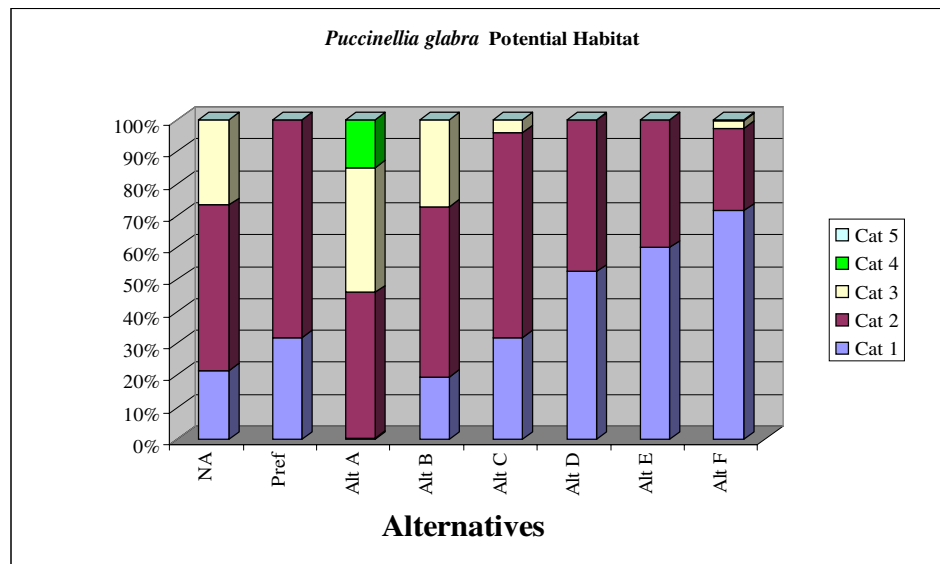
Papaver alboroseum, (Pale Poppy). The potential habitats of the plant are well drained open areas, recently deglaciated areas, rock outcrops, and sandy, gravelly areas and riparian areas. The *Papaver* or its habitat could be affected by activities relating to campgrounds, commercial special forest products, day use facilities, fish habitat projects, recreational cabins, vegetation management, hardened dispersed camping, invasion by exotic plants, minerals activities, mode changes: parking lots at trailheads, new roads, new trails, cabins, nonmotorized recreation use, hiking camping, OHV designated routes, summer, OHV other purposes, personal use special forest products, pest management, prescribed fire, recreational gold panning, destination lodges, fixed-wing flightseeing landings, guided hiking, helicopter landings summer, recreational equipment cache, or storage areas (fisheries), trail reconstruction, and utility systems. The differences between the potential effects of the alternatives are displayed in Figure 3-33. For individual project proposals, site-specific environmental analysis will include Biological Evaluations, which analyze the effects of those proposals on plants and animals and their habitats. As a result of the analysis, appropriate mitigation measures would be included in the project to sustain plant and animal species and their habitats. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-33: Distribution of potential *Papaver alboroseum* habitat on the Chugach National Forest by prescription category and alternative.



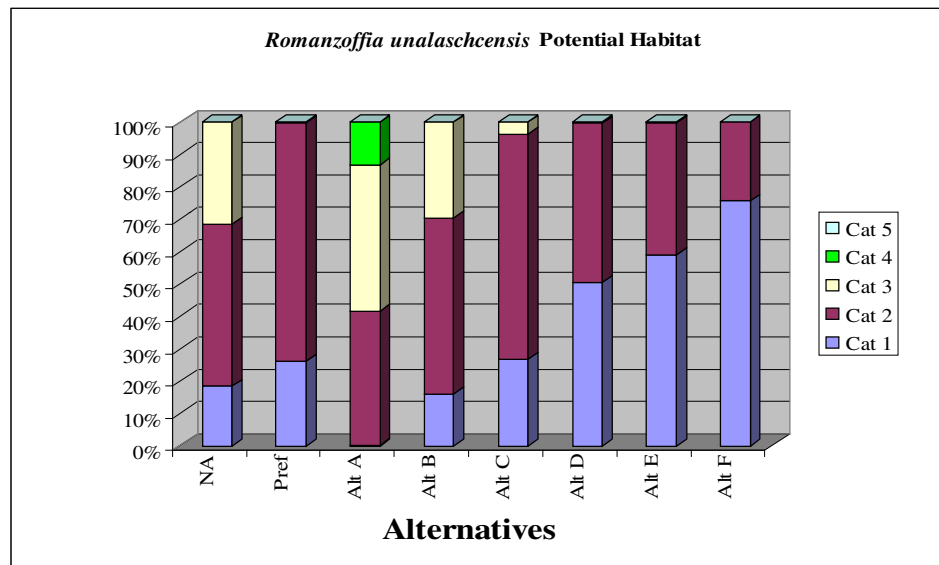
Puccinellia glabra, (Smooth Alkali Grass). The potential habitats of the plant are stabilized sandy, shingle or muddy beaches in the upper tidal zone. The *Puccinellia* or its habitat could be affected by activities relating to boat docks and ramps, invasion by exotic plants, marine transfer facilities, mode changes: parking lots at trailheads, ferry terminals, nonmotorized recreation use, hiking, OHV other purposes, personal use special forest products, fixed-wing flightseeing landings, guided hiking, storage areas (fisheries) and utility systems. The differences between the potential effects of the alternatives are displayed in Figure 3-34. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-34: Distribution of potential *Puccinellia glabra* habitat on the Chugach National Forest by prescription category and alternative.



Romanzoffia unalaschcensis, (Mistmaiden). The potential habitats of the plant are rocky, cliffy areas along maritime beaches, or under maritime influence. The *Romanzoffia* or its habitat could be affected by activities relating to boat docks and ramps, campgrounds, commercial special forest products, day use facilities, recreational cabins, vegetation management, hardened dispersed camping, invasion by exotic plants, marine transfer facilities, minerals activities, mode changes: parking lots at trailheads, ferry terminals, new roads, new trails, cabins, nonmotorized recreation use, hiking camping, OHV designated routes, OHV other purposes, personal use special forest products, recreational gold panning, destination lodges, fixed-wing flightseeing landings, guided hiking and climbing, helicopter landings summer, recreational equipment cache, SUP storage areas (fisheries), trail reconstruction, and utility systems. The differences between the potential effects of the alternatives are displayed in Figure 3-35. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-35: Distribution of potential *Romanzoffia unalaschcensis* habitat on the Chugach National Forest by prescription category and alternative.



Stellaria ruscifolia* ssp. *aleutica, (Circumpolar Starwort). The potential habitats of the plant are open gravelly areas and along streams in lowlands and in the mountains. The *Stellaria* or its habitat could be affected by activities relating to campgrounds, commercial special forest products, day use facilities, electronic sites, fish habitat projects, recreational cabins, vegetation management, hardened dispersed camping, invasion by exotic plants, minerals activities, mode changes: parking lots at trailheads, ferry terminals, new roads, new trails, cabins, nonmotorized recreation use, hiking, camping, OHV designated routes, summer, OHV other purposes, personal use special forest products, pest management, prescribed fire, recreational gold panning, destination lodges, fixed-wing flightseeing landings, guided hiking and climbing, helicopter landings summer, recreational equipment cache, storage areas (fisheries), timber harvest, trail reconstruction and utility systems. The differences between the potential effects of the alternatives are displayed in Figure 3-36. In addition, laws, regulation, policy, a combination of land allocations and Forestwide standards and guidelines will be applied to sustain the plant and its habitat. Therefore, any alternative may affect individuals but is not likely to contribute to a loss of viability.

Figure 3-36: Distribution of potential *Stellaria ruscifolia* ssp. *aleutica* habitat on the Chugach National Forest by prescription category and alternative.

